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THE
POPULAR SCIENCE
REVIEW.

A QUARTERLY MISCELLANY OF
ENTERTAINING AND INSTRUCTIVE ARTICLES ON
SCIENTIFIC SUBJECTS.

EDITED BY JAMES SAMUELSON.

VOLUME II.

LONDON:
ROBERT HARDWICKE, 192, PICCADILLY;
AND ALL BOOKSELLERS.
1863.

LONDON:
COX AND WYMAN, PRINTERS, GREAT QUEEN STREET,
LINCOLN'S INN FIELDS.

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THE

POPULAR SCIENCE REVIEW.

THE BRITISH OAK.

BY PROFESSOR JAMES BUCKMAN, F.L.S. F.G.S. F.S.A. ETC.

WHILST the discussion is still pending, of iron against wooden bulwarks, if only for the love we feel towards the "brave old oak," a few notes upon the forms of this truly national tree can hardly fail to be acceptable. At starting, however, we must bear in mind, that though we have ever looked upon the oak as so thoroughly British that we had almost been brought to think that it was made for the sole glory of our land, yet there are those who would wish to cast a doubt upon its true aboriginal nature, and who, according to their custom, represent everything great as borrowed from the Continent. What says, however, that pleasant discourser on forest trees, Jacob George Strutt, of imperishable sylvan fame:—"In proportion as the oak is valued above all other trees, so is the English oak esteemed above that of any other country, for its particular characteristics of hardness and toughness; qualities which so peculiarly fit it to be the 'father of ships,' and which are so admirably expressed in two epithets by that great poet, to whom the book of nature, and of the human heart, seemed alike laid open:—

> Thou rather with thy sharp and sulph'rous bolt,
> Splitt'st the *unwedgeable* and *gnarled* oak,
> Than the soft myrtle."—SHAKESPEARE.

Selby again, in his "History of Forest Trees," a work which should be in the hands of all lovers of the beautiful natural objects of which it treats, describes the finding of some bog oaks, which would almost connect the present race with a fossilized past:—

> At the Linden, the seat of C. W. Bigge, Esq., the trunk of a magnificent oak was extracted from a peat moss that fills a small basin or hollow,

evidently produced by the stagnation of a stream, which now passes through it, and which, at some distant period, had been dammed back by the fall of the trees upon its margins. This oak was covered by a layer of the peat to the depth of about three feet, and was discovered by probing the moss. The trunk, with a small portion of one of the larger limbs, was with great labour and difficulty dragged from its miry bed. The contents of the portion recovered contained 545 cubic feet, although the whole of the sap-wood had perished. The timber was perfectly sound, and the tree, by whatever accident it had been overthrown, had fallen in the vigour of its growth. When sawn up, the interior planks were found of a deep rich brown colour; those nearer the exterior darker, or approaching to black. A variety of elegant furniture has been made from the wood, but it has been found necessary, for fine cabinet-work, to have it cut into veneers, for, when worked in bulk, it is apt to crack and become warped. Remains of other huge oaks have also been met with on the banks of the Tyne, the Alne, and other rivers, as well as in various bogs and morasses; and we mention these instances to show that in a district where, at the present day, nothing but recently-planted oak or dwarfish timber from stock-shoots exists, in former times the monarch of the forest grew luxuriantly, and attained a splendid development; and also as an inducement to the planter not to neglect the liberal insertion of this national tree wherever soil and situation are found congenial to its growth. In other parts of England, the oak still grows in all its native magnificence of form and dimensions, and the remains of those ancient forests, which are chronicled by our earliest writers, and which, in the time of our Saxon ancestors, spread over the greater portion of the country, are still to be traced in the venerable but living relics of enormous oaks, many of which are supposed to number more than a thousand years.

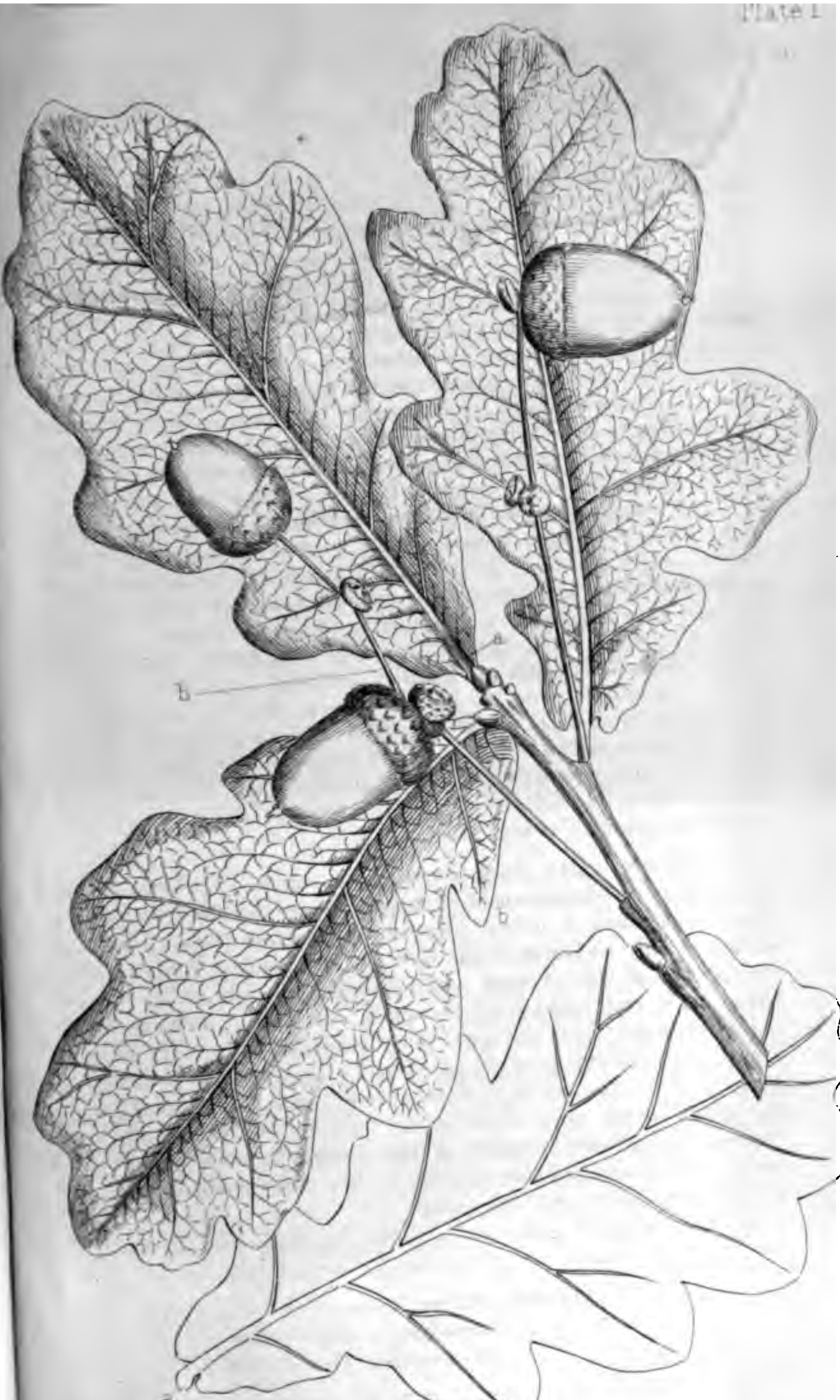
Not to neglect to plant the national tree! We hope indeed that there is no possessor of broad acres who does not esteem it a duty, regardless of profit, to provide for a succession of forest kings, if only to beautify the face of the country, and to leave the people of the present some grand living object to connect them with the history of the past. In fact, planting of the "British oak" has not only been considered a duty, but followed out with the keenest pleasure by the country gentleman. In so doing, the question has scarcely until lately occurred, is the British oak always the same? or, are there not different species, or at least varieties of the genus *Quercus*, which have been confounded by the planter? To this question we now propose to address our inquiries.

On referring to different authors, we shall find mention of the following names as applied to the British oak:—

1. Quercus Robur, *Linn.*
2. ,, sessiliflora, *Salisbury.*
3. ,, intermedia, *Don.*

This method of nomenclature would however be only tenable on the supposition that we considered the trees so named

Plate I



J. Sowerby sc.

Quercus Robur Pedunculata.

specifically distinct; but as we incline to believe them to be only varieties—though highly important as such—we intend to treat of them as follows :—

1st. QUERCUS ROBUR PEDUNCULATA.
2nd. „ „ SESSILIFLORA.
3rd. „ „ INTERMEDIA.

1st. *Quercus Robur pedunculata* is readily distinguished in trees separate from others by its robust habits, thick, gnarled, twisted, and more or less horizontally inclined branches. The leaves have comparatively few broad wavy indentations, and are set on a short leaf-stalk (petiole) (Plate I. fig. *a*), the fruit being situate on long footstalks (peduncles), varying from two to upwards of four inches (fig. *b*).

This is the typical British oak, the pride of our sailors, when men fought bravely, and did not care to vie with each other as to who should make the most secure skulking-places. The tree,—

Whose roots descend
As low towards Pluto's realms, as high in air
Its massive branches rise. The utmost rage
Of wintry storms howls o'er its strength in vain.
Successive generations of mankind,
Revolving ages flourish and decay,
Yet still immovable it stands, and throws
Its vigorous limbs around, and proudly bears
With firm and solid trunk its stately form,
A mighty canopy of thickest shade.—VIRGIL, *Georg.* ii. 291.

This is the tree that seems to be longer lived than any other in Britain, and though it would appear to be the prey of nearly, if not quite, two hundred species of insects, it has still had vigour of constitution to survive them all, and, in many instances, we might point to brave old trees which must have been veterans at the time of the Norman Conquest. Now, however, they are old and staggy, with hollow trunks truly—but what trunks!—from forty to fifty feet in circumference, presenting the following picture to us as it did to Spenser :—

There grew an aged tree on the green,
A goodly oak some time had it been,
With arms full long, and largely displayed,
But of their leaves they were disarrayed ;
The body big, and mightily pight,
Thoroughly rooted, and of wond'rous height :
Whilom had been the king of the field,
And mockel mast to the husband did yield ;
And with his nuts larded many a swine,

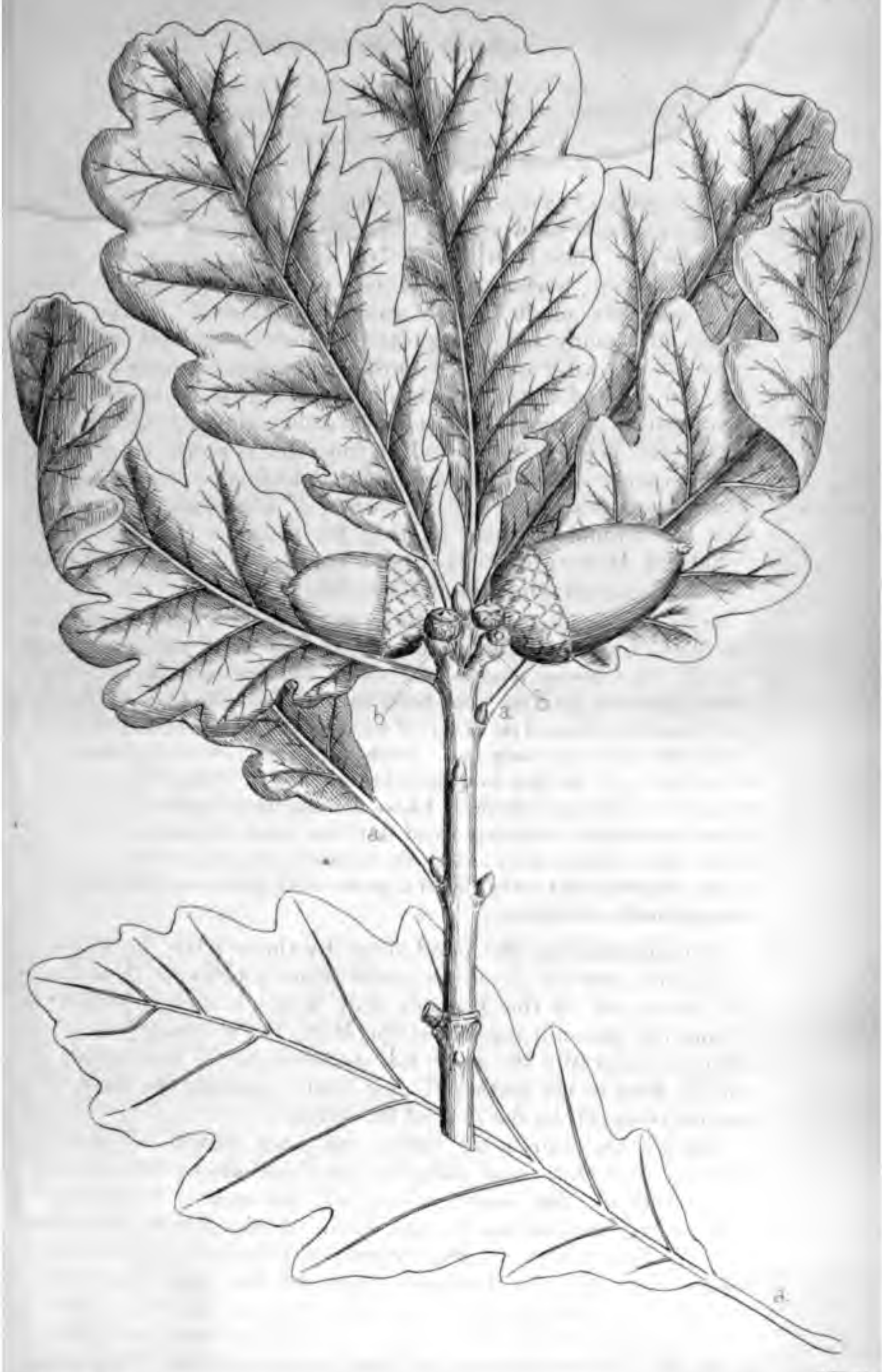
But now the grey moss marred his rine;
His bared boughs were beaten with storms,
His top was bald and wasted with worms,
His honour decay'd, his branches sere.—*Shepherd's Calendar.*

This indeed is a melancholy sight, like the Stag's Horn Oak by the roadside between Farnham and Woolmer, in the ancient boundary of Alice Holt Forest; yet this has a young tree growing by its side, perhaps one of his own children, which gracefully conceals much of his gaunt nakedness. In the same forest are many old staggy trees, their contorted horn-like branches sticking out in a most picturesque manner from the top and sides of a still leafy head. In these the white owls may still be seen peering out of dark cavernous hollows as they did in Gilbert White's day; and during the summer of 1861 we with pleasure watched their motions, which so minutely agreed with those described by the father of observing naturalists, that we cannot forbear quoting his remarks thereon in his "Natural History of Selborne," a not very distant parish from the Holt, and to which he indeed often refers.

> As I have paid particular attention to the manner of life of these birds (the White Owl), during their season of breeding, which lasts the summer through, the following remarks may not be unacceptable. About an hour before sunset (for then the mice begin to run), they sally forth in quest of prey, and hunt all round the hedges of meadows and small enclosures for them, which seem to be their only food. In this irregular country we can stand on an eminence and see them beat the fields over like a setting-dog, and often drop down in the grass or corn. I have minuted these birds with my watch for an hour together, and have found that they return to their nest, the one or the other of them, about once in five minutes; reflecting at the same time on the adroitness that every animal is possessed of as far as regards the well-being of itself and offspring.

Notwithstanding the good done by these birds in keeping under mice, all our eloquence could scarcely preserve them from the onslaught of the keeper; they were, however, protected during our pleasant sojourn at the Holt, but we much fear only, after all, to gratify the taste for stuffed birds, a *love* which is equally fatal to the feathered race (and especially the finest examples thereof), as the *hate* of the keeper.

But we are digressing sadly, and must return to *Quercus Robur pedunculata*, and complete our observations thereon with the statement that most, if not all, the nobler examples of oaks in England belong to this form. Selby directs attention to the "Flitton Oak, in Devonshire, of the *Sessiliflora* variety, supposed to be one thousand years old, and which is thirty-three feet in circumference at one foot from the ground." However, nearly every historical oak is of the pedunculate variety. In the Holt forest are still left some huge examples; the same



J.E. Sowerby sc.

W. West

Quercus Robur Sessiliflora

in the Dean forest; and Ringdon, in Swindon, Wilts, though disafforested, can yet show noble trees of this form. Indeed throughout England it is difficult to meet with many examples of any other form, except in Wyre forest, Worcestershire, where the tree next to be described is perhaps the more general, and it would also appear that in the New Forest the *Q. sessiliflora* is also frequently met with.

Quercus Robur sessiliflora may be generally described as of a more upright and formal habit. Limbs straighter and less gnarled. Bark usually smoother than the former. The leaf has many sinuosities, and is set on a comparatively long leaf-stalk (petiole)—(Plate II. fig. *a*).

The fruit on the contrary is so nearly sessile that it may be said to have little more than the indication of a peduncle (fig. *b*).

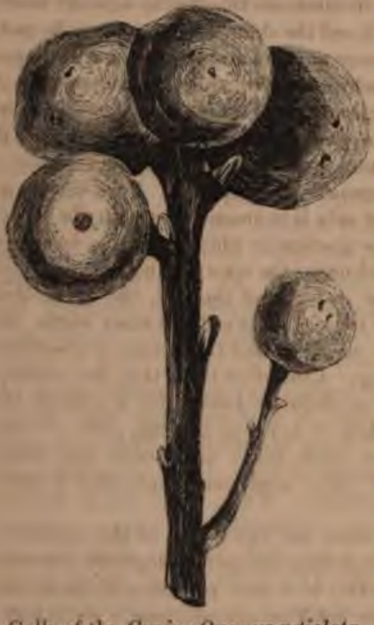
We have already stated our opinion that the sessile-fruited oak does not usually attain the huge dimensions of the pedunculate form; but on the other hand we incline to the belief that it grows more rapidly, and is best adapted for a lighter soil than the latter. There are conditions which might to a greater or less extent affect the quality of its timber, but we do not think that there is much difference in this respect. We believe that their wood has been used indifferently, and the quality is influenced by surrounding circumstances. Selby, in his "History of Forest Trees," states on this head, "The result, perhaps, of some original constitutional defect, or arising from the nature of the soil, situation, or other local peculiarities of the ground upon which the timber has been raised, such at least is the result of our own experience, as we have met with oak of the *peduncled* kind, its timber possessing all the inferior qualities attributed to, and supposed to be possessed exclusively by *Q. sessiliflora*." The longer, straighter spars of the Sessiliflora, in days when oak was so uniformly used for roofs, seem to have pointed out this variety for roof-timbering, and hence some of the finest ancient timbered roofs of this country have been ascertained to have been formed from its wood. With respect to these the opinion long prevailed that they were formed of the wood of the Spanish chestnut. This, however, is but a poor timber tree, as long before it could afford so large a scantling as would be required by the roof of the Parliament House at Edinburgh or of Westminster Abbey (both of which were supposed to be of chestnut), the chestnut would begin to decay at the heart; in fact just at the period when the heart-wood of oak begins to harden, that of the chestnut would appear to deteriorate.

Quercus Robur intermedia, having a petiole intermediate in length between the other two varieties described, and a peduncle varying from a quarter to one inch in length, may with propriety be deemed a variety intermediate between "Sessiliflora" and "Pedunculata," and a comparison of the three will substantiate its claim to this title.

As a tree it is impossible to make out any specific character from its mode of growth, and, indeed, without the fruit, it is extremely difficult even to distinguish it as a variety.

It occurs—only occasionally—in the Cotteswold district, and we suppose the same elsewhere. One meets with it here and there in the hedgerows, and in Oakley Park, the seat of Earl Bathurst, we can point out a few specimens.

Passing from the subject of the varieties of our British oak, it now remains to mention a most formidable enemy by which it has of late years been attacked, and so exclusively, that in plantations where may be found the American oaks, the Ilex oak, and Turkey oak trees, it has been the only one subjected to the operations of the new gall pest. It has long been known that our native oaks were subject to excrescences of different forms and sizes, such, for example, as oak apples, oakleaf galls, oak spangles, &c., all of which were ascertained to be caused by several species of *cynips*; but lately, we have to lament the introduction of a new species of the same insect, forming a new kind of gall, which, instead of attacking the backs of the leaves, as does the oakleaf gall, occupies the stem that belongs to the leaf; in fact, the attacked leaves seem to be converted into bunches of galls, as represented in the adjoining figure, which presents an illustration of the new pest. They are hard galls, more or less like the "nut-gall" from Aleppo, of which ink is made, and it will be seen that the little twig supports no less than five galls, in the interior of each of which may be found the maggot or *larva* of an insect; and, as this is effected at the expense of the buds and leaves, the mode of injury must be obvious, as the new twigs which would have been formed, had there been no galls, would



Galls of the *Cynips Quercus-petiolata.*
(Natural size).

in their turn have produced branches and leaves. Trees thus infested are crippled as though they had been subjected to constant pruning.

As much of the natural history of the *cynips*, by which these gall-nuts are formed, as is necessary for our purpose, may be gathered from a paper by Mr. Parfitt, who seems to have well studied the gall insect in Devon, its head quarters. We quote it from the Journal of the Bath and West of England Agricultural Society for 1861 :—

> The eggs deposited by the females in the oak buds in September remain there in a state of apparent quiescence till the following spring ; then as soon as the sap begins to flow, the irritant injected into the wound at the same time the egg was deposited, or possibly the combined action of the egg and irritant, causes the sap to diverge ; that portion of the bud which should have formed a young shoot, is converted into a spherical ball ; the outer scales of the bud fall away, and it is the woody secretion which entirely forms the gall. The cells in the gall are not elongated and regular, as in the young shoot, but confused and irregular ; and in the centre of each gall lies a young grub of the *cynips*, forming a living nucleus, around which is deposited a thin hard woody envelope, much more compact in substance than the sponge-like tissue which fills up the interstice between it and the shining outer coat of the gall. This compactness of structure is a necessary and all-wise provision of nature for protecting the delicate insect which lies within from destruction ; for if the gall were composed entirely of large spongy cells, the rapid flow of sap in the early spring would be more than the creature could consume, and it would consequently be drowned. I am aware that some naturalists incline to the opinion that the *larvæ* of the *cynips* feed on the gall. From this view, however, I venture to dissent ; for not only is it inconsistent with the structure of the creature's mouth, and the position in which the young *larvæ* are invariably found, with the head tucked under the apex of the abdomen, but if they fed on the substance or crude material of the gall, the undigested parts would certainly be found in the interior of its cell : in other words, the excrement would be there, for there is no outlet, and the lacteals or absorbent vessels of the gall could not take it up. I therefore think that the creature feeds entirely on the sap of the tree—an elaborate food fit for it without the need of mastication. This explains how it happens that the galls of commerce, with the insects in them, are so much better and dearer than those from which the *cynips* has escaped ; in a word, the tannic acid is more abundant.
>
> It has been before observed, that there are two broods of the insect in a season ; thus, those which do not emerge from the gall in September, remain on till the following April or May. This is a wise provision of nature for continuing the species, should anything befall the autumn brood ; and it is the more deserving of notice, because the gall-producing *cynips* has a deadly enemy which accompanies or follows it in its flight from bud to bud, and deposits an egg wherever it finds the egg of the *cynips*. Here, as soon as the *cynips* larva is hatched, the larva of the parasite is hatched also ; forthwith the latter proceeds to eat a hole in the skin of the rightful occupant of the nidus, and the

two larvæ go on growing together till the *cynips* is ready to assume the pupa state; then the parasite cuts the vital thread of the *cynips* and uses its skin for a pupal envelope for itself, and thus, instead of the gall-fly emerging into day, a beautiful green insect makes its appearance on the stage of life. I had the pleasure of first discovering this parasite while engaged in studying the *cynips;* it belongs to the genus *Callimome,* and from the fact of having discovered it in Devonshire, I gave it the name of *Callimome Devoniensis.* It is one of the handsomest of our British insects; its costume a brilliant green, shot with gold; the abdominal segments green, gold, and purple; legs yellow; tarsi reddish; and it has four beautiful transparent and irridescent wings.

It has been stated that oak-galls are produced at the expense of acorns. From this view, my experience leads me to dissent. In exceptional instances, it may have been the case; but, as a rule, the *cynips* confines its attacks to young trees and young growths in hedges, within a range of ten or twelve feet from the ground, and the nearer the ground the more numerous the galls. Young trees which have not attained a greater height than that I have indicated, suffer so much, that many of them can scarcely make headway against their foe; and in several nurseries I have visited, where it might be expected that greater care would be paid than in the case of ordinary plantations, the young stock of oaks has been rendered quite unsaleable by the pest. This year I have noticed the progress of the insect on two groups of young English and Turkey oaks growing side by side; and although there are hundreds of galls on the English oaks, there are none on the Turkey oaks. From this I am led to infer that the species of *cynips* now under notice is confined in its depredations to the English oak; and as it invariably selects trees of younger or restricted growth—probably because the temperature at a higher elevation than ten or twelve feet from the earth is unfavourable to it—it would seem that children might be advantageously employed in young plantations in collecting the galls by means of cutting hooks, such as are used for thistles. The galls, when once collected, might either be crushed for tanning purposes, or consumed by fire, and if the process were repeated for two or three seasons, it is more than probable that the plantation would be altogether freed from the pest.

These able remarks not only well describe the nature of the attack, but also point to a cure, a matter to which we would direct the most serious attention of the planter: for we may state that, in 1858, we saw some very small oak trees, in the neighbourhood of Dawlish, Devon, from which some hundreds of these galls might have been gathered. This was the first time we had noticed this pest, though it appears that it had been under Mr. Parfitt's notice as long as a dozen years. Since then (1858) we have traced it in its progress as follows:—

Having observed the galls in Devon in 1858, we were yearly on the look-out in the Midland and Eastern counties for its appearance, and the following dates will show that its spread, though gradual, was sufficiently rapid:—

The galls were gathered in Devon, in	1853
The same kind in Somerset, in	1854
In Gloucester, on the west side of the river Severn, Forest of Dean, in	1855
In Gloucester, east side of the Severn, and as far as Oakley Park, Cirencester, in	1856
In Worcestershire, in	1857
In North Wales, Beddgelert (pointed out to us by John Savory, Esq.), in	1859
In Sussex, very sparingly, in	1860
In Alice Holt Forest, and far from abundant, in	1861
About Hastings, very plentifully, in	1862

We have this season observed a lot of the young galls, but last year, for the first time, we discovered that, in many cases, the maggot had been extracted by some small bird, probably one of the titmice, and, if so, wherever young oaks may be growing, it should afford an additional reason for the protection of these useful birds. The magnitude of the evil, unless checked by some means, may be estimated from the fact that, in 1856, we could scarcely find half a dozen galls within a wide district, and now all around may be found trees, not more than ten feet high, upon which are no less than from one to five hundred distinct galls.

We conclude these remarks upon our native oaks with the fervent hope that in "Merrie England" it may ever be as described by dear old Chaucer :—

A pleasant grove

* * * * *

In which were okes grete, streight as a line,
Undir the which the grass so fresh of hew
Was newly sprong, and an eight fote, or nine,
Every tree well from his fellow grew,
With branches brode, laden with levis new,
That, sprongin out agen, the sonnè shene.
Some very rede ; and some a glad light grene.—

The Floure and the Leafe.

DESCRIPTION OF THE PLATES.

Plate I. Quercus Robur pedunculata, nat. size, from Oakley Park, Cirencester.
  Fig. *a.* *Petiole* or leaf-stalk.
  b. *Peduncle* or fruit-stalk.

Plate II. Quercus Robur sessiliflora, from Wyre Forest, near Kidderminster.
  Fig. *a.* *Petiole.*
  b. *Peduncle.*

THE COMMON RED WORM OF OUR RIVERS.

(TUBIFEX RIVULORUM).

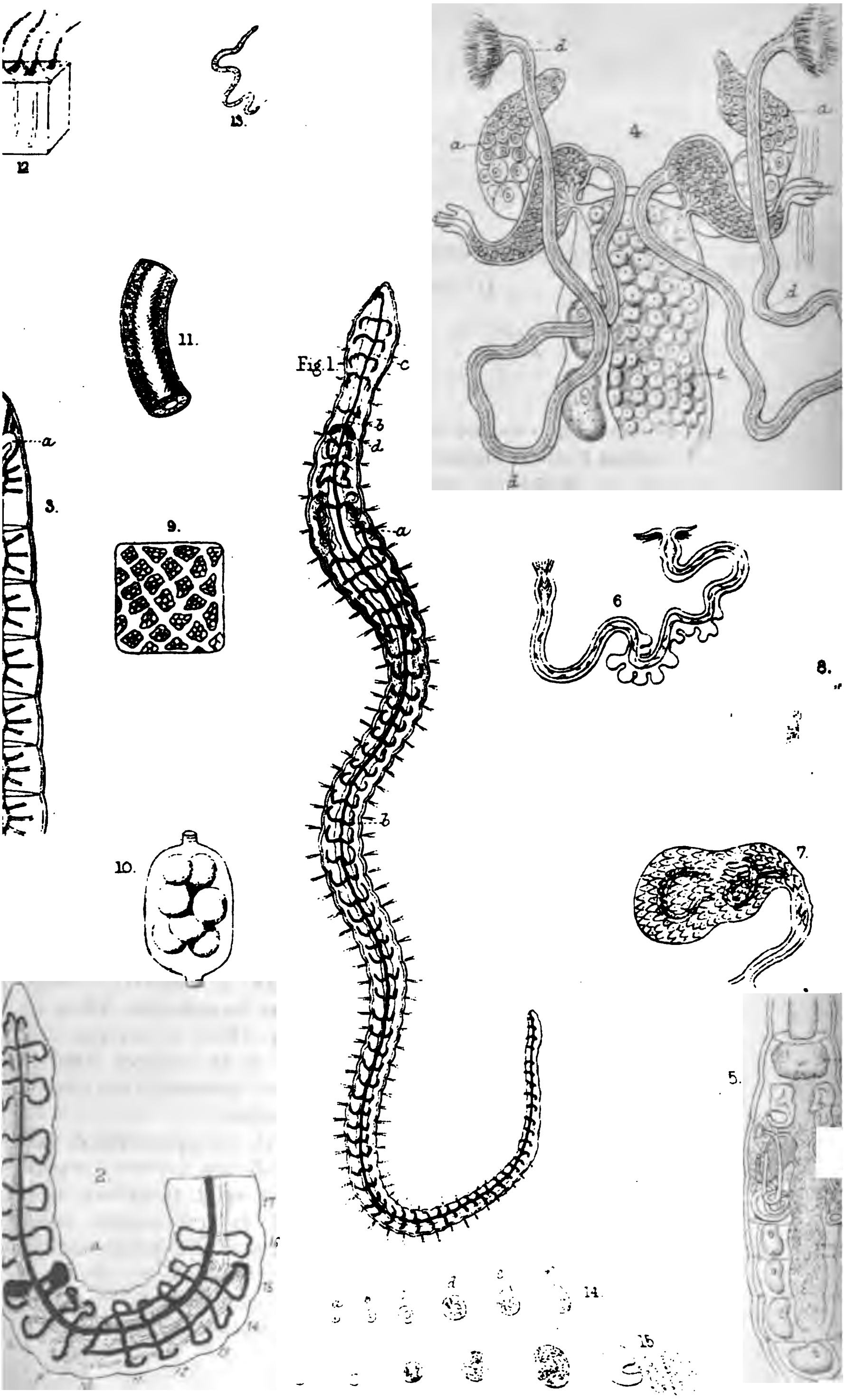
BY E. RAY LANKESTER.

NO river has enjoyed so large a share of odium as our old friend Father Thames. The medical world anathematizes its noxious exhalations; our witty contemporary "Punch" ever and anon cracks a joke at its expense; but like all old folks who have jogged along quietly for a series of years in the same smooth channel, our patriarch gives little heed to the insults that are heaped upon his grey head, or retaliates upon his assailants by giving them an additional dose of poison.

However we may agree with its accusers, from a sanatory point of view, we don't mean to fall out with the good old stream that has often-times served as our high road eastwards or westwards; we mean rather to court its favour and earn its good wishes, for we have found something in the midst of its filth, which will, we trust, redeem it from utter condemnation, and will serve to show that there are not only "books in running brooks," but that even muddy rivers yield themes for study and investigation.

The living object which we are about to describe is found not alone in the river Thames, but also in many others. We have, however, obtained it from our own stream, near Waterloo Bridge, at low-tide, and it is then so plentiful as to tinge the mud, which serves as its habitat, with a dull-red colour. Doubtless our readers will be somewhat incredulous when we assert that repulsive as is the locality in which it occurs, nay, distasteful (to use a mild expression), as is the object itself, a worm, to the large majority of unscientific persons, this one is really beautiful as seen under the microscope.

It resembles a crystalline snake, both in appearance and movement, through whose hyaline skin all the internal organs of life are seen in active operation. Not only, therefore, is it interesting as a microscopical object, but its transparent envelope, which reveals its internal anatomy, and the great facility with which it may be obtained, point it out as an object of especial value to young students in the anatomy of the lower animals; and we trust that our short review of its various parts



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The Red Worm of rivers & its anatomy.

may be the means of inducing many such persons to examine and confirm our statements concerning its anatomy.

Tubifex rivulorum (the River Tubifex), for so it has been called by the eminent naturalist Lamarck, belongs to the family of Lumbricidæ, or Earthworms; and the sub-family Naiadidæ, or water-worms, according to some naturalists (for they burrow in the mud of rivers), whilst others rank it amongst the "Setigeræ," or bristled worms (in consequence of its being furnished with two lateral rows of bristles), but in the same group, Lumbricidæ or Lumbricini. However we need not discuss this question with our differing authorities; but may just observe that Tubifex is a genus of Annelides, allied to the Earthworm, having the rings indistinctly marked, and that it forms one of a group of fresh-water worms which burrow in the mud of rivers and ponds. It is from half an inch to an inch and a half long (Plate III. fig. 13), and is attenuated at each end.

Owing to its various modes of reproduction it increases very rapidly, and its numbers cause patches of red on the surface of the mud on which it burrows, for half the bodies of the worms are protruded (fig. 12), the other half remaining in the ground. When the worms are disturbed, they withdraw their bodies, and then "the red patches instantly disappear, from the retraction of the animals."*

With the aid of the lens, its "annulose," or ringed character, is revealed, but, as just stated, not so clearly as in the earthworm.

Our figure (1) represents a magnified view of the animal, and from this it will be seen how clearly the internal organs are visible. These we shall now proceed briefly to describe.

First we have along the whole length of the body the digestive canal (fig. 1, *a*), a dark tubiform organ, and attached to it (fig. 1, *b*), the dorsal blood-vessel of a deep red colour. Extending from the eighth to the sixteenth ring we find a white semi-opaque mass, comprising the organs of reproduction, which are of a very interesting nature, for we here find, as in many allied forms, both the male and female united in one individual.

In connection with the red dorsal vessel are two hearts, if we may so term them (fig. 1, *d*), which impel the blood through the numerous blood-vessels, of which the rhythmical dilatations and contractions are clearly distinguishable.

We have already remarked that the *external envelope* of *Tubifex* is transparent. Let us now add that it consists of two layers, namely, a very thin "epidermis" or outer integument, and an internal skin or "chorion," which is intimately connected with the muscular membrane lying underneath the skin. The

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* Griffith & Henfrey's Microscopic Dictionary (Van Voorst), article "Tubifex." Here also will be found the Bibliography.

"muscular membrane" envelops the whole body, in common with the skin, and attached to it are transverse muscles which constitute the boundaries, as it were, of the rings of the body. These muscles, by their contraction, impart to the little Tubifex its undulating and longitudinal movements, and a probable modification of them is found in another set of muscles at the mouth of the animal, these latter being intended to regulate the movements of the pharynx (fig. 1 *c*).

The reader will no doubt be somewhat surprised to hear that so diminutive an organism should be furnished with a complicated nervous system, perfectly adapted to its general structure, and for the fulfilment of its wants.

A careful examination of the little annelide is necessary for the definition of the *nervous system*, which is found to resemble the other forms of this order. It consists of a long double cord of nervous fibre, which runs throughout the length of the worm, and gives off in each segment of the body three pairs of nerves, which direct the movements of the muscles belonging to that ring. The points in the nervous cord whence these nerves spring are slightly enlarged, and are called "ganglia" (fig. 3).

In the first ring of Tubifex we find a very large ganglion (fig. 3,*a*), the two nervous cords enlarging into a round mass composed of nervous matter; this represents the brain of higher animals, and from it spring two pairs of nerves, one of which is connected with an organ supposed to be the eye; but of this there is great doubt. We ourselves have tried several experiments to ascertain whether the Tubifex has been favoured with organs of sight or not, and have come to the conclusion that it is blind. The Creator has nowhere exercised his Almighty power uselessly, and eyes would certainly be of no use to our little annelide, as his food consists merely of the mud which he inhabits, from which all the nutritive matter is extracted in his intestinal canal.

Strange though it may seem, the Tubifex is provided with a *liver*, and a very large one too, and is therefore liable, in common with the human race, to bilious attacks. The intestine is covered throughout its length with a dark yellow membrane containing curious little granules (fig. 14), and capable of secreting and projecting a fluid into the intestine—this is the liver—and is no doubt most important in digesting such *bonnes-bouches* as Thames mud affords.

The animalcule is also provided with excretory organs answering to the *kidneys* in higher animals—there are two in each ring of the body—consisting of little tubes with an internal and external opening covered internally with minute vibratile hairs or "cilia," which are also continued around the expanded orifices, as seen in fig. 6. When the Tubifex is placed under the microscope, these "cilia" may be seen in rapid motion, and present a most beautiful appearance. The same excretory tubes may be found in the common earthworm (*Lumbricus terrestris*), and are there visible to the naked eye. These cilia are found in other parts of the body—the interior of the intestine is lined with them, and they are easily seen at the extremities of the body, in continuous movement when the Tubifex is under the microscope.

We must now say a little more about the *blood-vessels* of our worm. Besides the long vessel which runs along the intestine, called the dorsal vessel, we find another placed below the intestine, of rather smaller proportions, also running through the whole length of the body. These two blood-vessels are connected by smaller ones, as seen in figs. 1 and 2—a pair in each ring of the body; in the seventh ring of the body, counting downwards from the cephalic or head-segment, we find the two hearts, which are merely enlarged lateral vessels (fig. 2 *a* and fig. 1 *d*). It is a most beautiful sight to see these little hearts contracting and expanding while they send the blood through the various ramifications of the blood-vessels. In the region of the reproductive organs (from the eighth to the sixteenth ring of the body), there is an interesting modification of the lateral vessels. They are connected by two vessels which run parallel with the great dorsal and ventral arteries, the arrangement of which will be best seen from the plan of the circulation given in our drawing (fig. 2).

We must now say a word or two concerning the reproductive apparatus, which is very complicated, the male and female organs being, as we before said, united in the same individual. In the eighth ring of the body, underneath the intestine, there is a round semi-opaque mass (fig. 5 *a*); this is the male glandular organ, and at the proper season of the year it is full of the spermatic filaments, which are often found collected together in discs somewhat resembling the beautiful little Sun animalcule (fig. 8). At a certain period the case enclosing these "Spermatozoa" bursts, and they float into the cavity of the body; thence they pass into a pair of ciliated tubes which are found coiled up in the tenth ring of the body (fig. 4 *d* and fig. 5 *e*). These little tubes, like the excretory tubes, have large trumpet-shaped mouths, and are lined with minute cilia, the arrangement of which is seen in fig. 11. The arrangement of the other organs of reproduction will be best seen in figs. 4 and 5. The ovaries (fig. 4 *a*), contain eggs in all stages of development, which pass from them into a large cavity where they are probably fecundated, as we find the ciliary tubes likewise connected with this part of the body. At the time that the eggs are deposited they are enveloped in little gelatinous capsules, each containing two or three eggs (fig. 10). These little capsules are formed by two glands found in the eighth ring of the body (figs. 7 and 5 *b*); they present a most beautiful structure, being composed apparently of polygonal cells: in their interior are found little vermiform bodies which assist in the secretion of the fluid that forms the egg-capsules. The eggs are probably deposited by a spontaneous dehiscence or rupture of the body, there being no natural outlet. Fig. 9 represents a (probably) secretory organ met with in the ninth ring of the body. Its function is not known.

Whilst speaking of the circulatory system we should have mentioned that the general cavity of the body is filled with a fluid which surrounds all the internal organs. It contains numerous small granules of various sizes, very similar in appearance to those found in the *quasi* liver enveloping the intestine (fig. 15). This liquid is probably merely pure water which brings the needful oxygen to the capillaries of the Tubifex, and answers the purposes of *respiration*. Such an arrangement is met with in many annelides, and is known as the chylaqueous system.

Our little Tubifex not only presents us with a wide field for study and amusement in the investigation of its anatomy, but it actually forms the habitat of at least two very interesting forms of animal life. One of these is met with in the interior, the other attached to the exterior of the body. The animalcule which resides in the interior of the Tubifex is a species of Opalina; it is very minute, and is covered by spiral rows of cilia, giving it, when in motion, an extremly beautiful appearance. It is one of the lowest forms of animal life belonging to Ehrenberg's class Infusoria. The other parasite which we have met with in studying the Tubifex is the beautiful Vorticella. We have examined but few specimens without finding a cluster of these exquisite living forms attached to the head or tail of the worm. The Vorticella, like the Opalina, is very low in the scale of creation, but it is of an entirely different form: supported by contractile stems there are numerous cup or bell-shaped bodies fringed round their margins with beautiful cilia.

Thus it will be seen that even in localities and substances which are repulsive to the ordinary mind, the inquiring student may find living forms of intricate structure performing complicated natural functions, and affording a habitat for still simpler but equally interesting forms of life. Even this imperfect and cursory review of the anatomy of the little Tubifex cannot fail to have afforded confirmation of the great truth, that all things are created in wisdom, and we may once more repeat that not only is it possible for the thoughtful man to read "sermons in stones," and find "books in running brooks," but that even the muddy bed of a broad river yields its volumes for the edification of the inquiring mind.

ANÆSTHETICS.

BY T. L. PHIPSON, M.B., PH.D., F.C.S.

BY anæsthetics are understood certain substances which have the property of inducing a peculiar state of the nervous system called anæsthesia, and thereby rendering us insensible to pain. They rank among the most powerful, and, at the same time, most useful agents that man has hitherto obtained from the hidden treasures of nature. From the moment of his birth (and perhaps even some time before birth), man is liable to experience what is called pain. The human body is so organized that, in a state of perfect health, we feel nothing; and there are some persons, though few indeed, who pass through life almost without knowing what pain is, whilst others again are almost constantly in a state of suffering. When pain is felt in any part of the body, that part is not in its normal condition, it is no longer in the state of insensibility which characterizes perfect health.

But pain is not without its uses: it warns us from danger, and without its existence our own existence would infallibly cease. For instance, if no pain were felt when the hand or foot is placed in the fire, we should not be tempted to withdraw it unless we happened to see it consuming. Some time ago a labourer lost his leg by sleeping too near a lime-kiln; he *felt* nothing till he awoke, when it was too late. Likewise, if no pain were felt when boiling water, or some powerfully acrid substance, is poured down the throat, we should not be tempted to desist from introducing it into the body, and so our life would, sooner or later, be inevitably destroyed. In lower animals, where the organs of sensation cannot be detected so distinctly as in man, and in some where such organs seem indeed to be completely wanting, there is still an existing faculty equivalent to pain, and followed by similar effects: thus, if we touch the tentacles of a sea-anemone, in which organs we can find no nerve-fibres, the animal instantly withdraws them as if hurt, in the same manner as a dog would withdraw his leg if his foot were pricked with a pin. In the human body, we have three kinds of nerves: viz., the nerves of sensation, the nerves of motion, and the nerves of organic life, which govern the functions of digestion, respiration, secretion, &c. But these three kinds are so intimately connected in the animal economy that one of them may, in certain cases, react upon the others, so that all three are capable of giving rise to pain; the first directly, and the others indirectly, by acting through the first. But happily for us, the study of nature has placed in our possession several means of allaying pain; it has procured us a series of substances which act upon the nervous system so as to deprive it of its faculty of producing pain, sometimes partially, and sometimes most completely, without interfering in any great degree with the other functions of the body.

Some of these means of allaying pain consist in producing sleep, either perfect or partial. The physiology of sleep is little understood, and, indeed, next to life and death, sleep is perhaps the most inexplicable phenomenon inherent to our nature. At certain intervals, we feel an irresistible desire to repose, and sleep comes on gradually. Its influence is felt by certain portions of the nervous system; other portions never sleep. The nerves of organic life continue their functions during sleep, the heart beats, circulation goes on, respiration and digestion continue, but the nerves of motion and of sensation have momentarily lost their power; consciousness is gone, voluntary motion disappears, hunger and thirst are absent, and so likewise is pain. Such is complete or perfect sleep. But it happens sometimes that sleep is partial or imperfect, and then some curious phenomena are observed. Intelligence may be more or less active, and sensation may be possible to a greater or less degree, but never to so great an extent as in the waking state. Generally, in imperfect sleep, consciousness is only partial, volition incomplete, and sensation dull. This state of incomplete sleep gives rise to dreams and to somnambulism. The former are odd manifestations of the intelligence no longer completely conscious. The latter may be either natural or artificial (mesmerism).

In somnambulism the intelligence is more active than in an ordinary dream; the nervous system, only partially subdued by sleep, is capable of bringing into action the senses and motion, but the faculty of feeling pain is almost, if not entirely absent, and moreover the somnambulist has no consciousness of danger. Hence natural somnambulism, which varies in intensity from simple sleep-talking to the most remarkable physical and intellectual feats, is a dangerous condition, inasmuch as we are no longer able to take care of ourselves. However, somnambulists have frequently avoided dangers in the most astonishing manner.

Artificial somnambulism, or mesmerism, as it is sometimes termed, only differs from the latter in being produced by artificial means. In both cases, the nervous system is more or less subdued as in ordinary sleep; organic functions (respiration, digestion, &c.), continue, but sensation is incomplete or annulled, and the power of feeling pain often completely absent. The manifestations of the intelligence are similar to those in dreams. The somnambulist, whether his sleep be natural or artificially provoked, will generally answer questions that are addressed to him, and in artificial somnambulism, or mesmerism, the intelligence is frequently in an extraordinary state of activity. This activity is, however, never complete; consciousness is absent, and though memory is often remarkably precise, and certain other intellectual faculties acquire, for the time, an extraordinary development, it is absurd to imagine that somnambulists have the power of seeing into the future, &c., as many persons, unaccustomed to the study of physiology, have supposed.

Certain chemical substances have the peculiar property of acting upon the nerves and producing sleep, even when administered in very small doses. These substances act upon the nerves, as is proved by applying them directly upon a nerve, and induce a nervous state, in which no pain, however violent, can be experienced by the person submitted to their influence. They differ by this property from all other known substances. Some of these compounds are extracted from certain vegetables, others are produced artificially in the laboratory. Plants which contain these subtle and powerful agents have been marked by the human race for many centuries, but it was reserved for modern chemistry to extract the active principles themselves, in a pure state, and ascertain their composition and properties. Among these plants are the poppy, the mandrake, the hemp plant, &c.

The mandrake (*Atropa mandragora*) has been used for many centuries to allay pain. Eighteen hundred years ago, Dioscorides stated in his writings, that, in his time, it was given "to cause insensibility to pain in those who were about to undergo any cutting or cauterizing operations." These persons, he tells us, "are thus thrown into a deep sleep, and do not perceive the pain." The Greeks and Romans used the root of the plant steeped in wine. Pliny also mentions the use of the mandrake as possessing powerful narcotic properties, and as being used for injuries inflicted by serpents, as well as for surgical operations, in order to assure insensibility to pain. Apuleius has also spoken of it in a similar manner.

Atropa mandragora, like the *Atropa belladonna* (deadly nightshade), and other plants of the genus *Atropa*, belongs to the family of *Solaneæ*, which contains also the tobacco-plant

(*Nicotiana*), the potato (*Solanum*), and several other important vegetables. It owes its pain-allaying properties to a principle called *Atropine*, a crystalline alkaloid, first discovered in *Atropa belladonna*. Though seldom or ever used at present, the root of the mandrake was frequently employed, with opium and other narcotic drugs, in ages gone by. Theodoric, a pupil of Hugo, who lived in Italy during the latter half of the thirteenth century, gives us, in his work on surgery, the following curious recipe, which shows that he was perfectly aware that surgical operations could be performed without causing any pain to the patient, by employing certain drugs. His indication runs as follows:—"The making of a flavour for performing surgical operations, according to Dominus Hugo:—Take of opium, of juice of unripe mulberry, of hyoscyamus, of the juice of the hemlock [*Cicuta*], of the juice of the leaves of unripe hemlock, of the juice of the wood-ivy, of the juice of the forest mulberry, of the seeds of the lettuce, of the seeds of the dock that hath a large apple [*Datura*], each an ounce; mix all these in a large brazen vessel, and then place in it a new sponge; let the whole boil as long as the sun lasts in dog-days, until the sponge consumes it all. As oft as it is required place this sponge in hot water for an hour, and let it be applied to the nostrils of him who is to be operated upon, until he has fallen asleep, when the operation may be performed."

Here we have opium, the narcotic juice of *Papaver somniferum*, *Hyoscyamus niger*, *Cicuta virosa*, and *Datura stramonium*, together with the less active lettuce, some of the most powerful narcotic vegetables known to us at the present day.

In 1579, Bulleyn, an English writer, described a means of putting patients to sleep, in order to practise the operation of lithotomy. He employed the mandrake. And in 1608, Baptista Porta, in his work on "Natural Magic," gives various receipts for medicines producing insensibility to pain. Among them is one for a "sleeping apple" (*Pomum somniferum*), composed of mandrake, opium, &c., the flavour of which is prescribed to be inhaled by the nose. In the same work it is stated, that certain soporific plants will yield a "quintessence" which will overwhelm one with profound sleep. This is not surprising, when we know that the *Magisterium opii*, an extract of poppy or sort of impure morphia, figured in the Pharmacopœia as early as the seventeenth century.

Of late years, the mandrake has almost completely given way to the deadly nightshade (*Atropa belladonna*), a plant which is well known to have greater power in annulling sensibility than any plant now in use, unless it be the aconite (*Aconitum napellus*).

The plants which contain pain-allaying principles, used at the present day, may be classed as follows:—In the family of Solaneæ, *Atropa belladonna* and *A. mandragora*, *Hyoscyamus niger* (henbane), *Datura stramonium*, *Nicotiana tabacum*; among the Papaveraceæ, *Papaver somniferum*; in the family of Ranunculaceæ, *Aconitum napellus*; among the Compositæ, *Latuca virosa*; in the Scrophularinæ, *Digitalis purpurea* (foxglove); and in the Umbelliferæ, *Conium maculatum*, and *Cicuta virosa*. There are others I shall mention presently.

From all of these, certain active principles, called alkaloids, have been extracted. They have all a most remarkable influence upon the nervous system, and the alkaloids extracted from them constitute some of the most violent poisons with which we are acquainted. Some of them have, moreover, a peculiar action upon the eye; thus, for instance, *Atropa belladonna* causes the pupil to dilate in so extraordinary a manner that it is not difficult to ascertain that a child has eaten the large cherry-like berries of this shrub, when, on approaching a lighted candle close to the eye, we find that the pupil does not contract as usual. Again, *Datura stramonium* (Thorn-apple) is apt to produce blindness for a time when taken in high doses. The calming influence of tobacco (*Nicotiana*) is well known; and headaches cease as if by magic after a short sleep induced by eating lettuce (*Latuca*). Among the mild producers of sleep should be mentioned, also, the hop-plant (*Humulus lupulus*). Pillows stuffed with hops while in flower give repose when others, however soft, have not the power of doing so.

As to opium, the property of the common white poppy (*Papaver somniferum*), as a soother of pain and a giver of sleep, has been known for ages. Opium is the dried juice of the seed-vessels of this plant, and derives its name from the Arab word *Afioum*. Its remarkable virtues are almost entirely owing to the alkaloid called *Morphine*, which it contains, together with a number of other interesting compounds.

The Indian hemp (*Cannabis indica*), which appears to be only a variety of our common hemp (*C. sativa*), possesses medical properties very similar to those of opium. Like the latter, extract of hemp (known as *Haschish*) exhilarates, intoxicates, induces sleep and anæsthesia,* generally followed by headache, nausea, despondency, &c. Hemp was known to the Greeks and Romans, but they were ignorant of its remarkable narcotic and anæsthetic properties. It was used by the Scythians to allay grief and melancholy; they inhaled the fumes given off when the seeds of the plant were thrown upon red-hot stones placed upon the ground in the centre of a closed tent. In the East, opium and hemp are smoked or eaten as a luxury, on account of the peculiar intoxication they produce, and people who once become habituated to these dangerous medicines remain slaves to them generally for ever.* The criminals of Barbary endeavour to procure a drug prepared from hemp before undergoing amputation for crime; under the influence of this drug they do not feel the knife of the executioner.† A Chinese physician, Hoa-tho, who lived about 230 years before the Christian era, is said to have used hemp as an anæsthetic in surgical operations. The chemistry of hemp is not yet complete, but its remarkable intoxicating and pain-allaying properties appear to reside in the resin which every part of the plant contains in considerable quantity. The peasants who gather hemp in our climate often complain of headache after being long in the field.

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* Incapability of feeling pain, &c.

According to Dr. O'Shaughnessy, the hemp-resin will sometimes induce that curious nervous effect known as *Catalepsy*, a condition of the nervous system which few have seen, and which many discredit. It has been once remarked in a patient who had taken a grain of hemp-resin, when his arm was lifted by the physician it remained motionless in that position; and the same occurred with the other limbs, they remained motionless in any position in which they were placed.

Under the influence of hemp, also, all notion of *time* and *space* is apt to vanish completely.

Aconite has been found useful in cases of rheumatism, gout, neuralgia, toothache, &c. It is a powerful medicine, and can only be administered in small quantities; if given in too large a dose, it is apt to produce temporary insanity or death. Its peculiar action on the nervous system is owing to the principle *Aconitine*, by whose virtue it lulls the most excruciating pain, and has been found particularly beneficial in rheumatic complaints.

Opium and hemp are, perhaps, more dangerous substances to deal with than other pain-allaying compounds which I shall mention hereafter. However, in 1774, Ambroise Tranquille Lassard, surgeon to one of the Paris hospitals, recommended the employment of a narcotic such as opium previous to serious and painful operations. And in 1782, Weiss, a pupil of Petit, of Paris, narcotized Augustus, king of Poland, and amputated part of the king's foot without his perceiving what was taking place.

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* The religion of the Eastern nations forbids the use of wine; hence they have habituated themselves to the use of these intoxicating drugs, which are far more hurtful.

† We all know the tale of the "Old Man of the Mountain;" his followers committed assassination under the influence of hemp preparations which he gave them.

In 1784, James Moore, surgeon at St. George's Hospital, London, introduced a plan for lessening pain during operations by compressing the nerves proceeding to the part.

Artificial somnambulism (or Mesmerism), of which I have spoken before, is said to have been used as an anæsthetic agent for the first time in India in the year 1845. Since then it has been applied with considerable success in Europe and America; being first adopted in America, then in France, and afterwards in England. Dr. Esdail, of Perth, who has written a pamphlet upon the subject, brings forward 261 personal observations of surgical cases performed without pain during mesmeric sleep.

The art of mesmerizing often exhausts the strength of the person who induces this state of insensibility in the patient; some patients requiring only three-quarters of an hour, others as much as twenty-four hours' mesmerizing before falling into the somnambulistic state. The process called *Hypnotism*, discovered by the late Dr. Braid of Manchester, appears much simpler than the ordinary method of mesmerizing by the eyes, by passes, and I shall have occasion to refer to it again.

Since the discovery of ether and chloroform, the use of mesmerism to produce anæsthesia appears to be almost abandoned; not so, however, with hypnotism, which seems about to revive.

The discovery of the different gases—carbonic acid gas, in 1756, by Black; oxygen gas, in 1774, by Priestley; nitrous oxide gas, a little later, by the same, &c. &c., gave rise, in England, to the supposition that they might be useful in the treatment of certain diseases, and the system of *Pneumatic medicine* was imagined. This system consisted in causing the different kinds of gases to be inhaled by the patients; it was thought that such a treatment would prove very beneficial in consumption (*Pthisis*). A medical pneumatic institution was accordingly formed at Clifton, near Bristol, by Dr. Beddowes, and huge reservoirs of gases were established for the use of the sufferers. In the year 1799, Humphry Davy, who had just completed his apprenticeship, was appointed the superintendent of this establishment. In the summer of 1800, Davy published some researches on the gas called *nitrous oxide* or "laughing-gas," and on the effects produced when nitrous oxide and other gases are inhaled. He experimented upon himself, and found that nitrous oxide relieved him from headache after a profound fit of intoxication induced purposely by drinking a bottle of wine in eight minutes. After many similar observations, he came to the conclusion that "as nitrous oxide seems capable of destroying physical pain, it may probably be used with advantage during surgical operations in which no great effusion of blood takes place." This idea had been formed after ten months of continuous and often hazardous experiments. It was on the 16th of April, 1799, that Davy inhaled nitrous oxide for the first time; he states that the introduction of this gas into the lungs was accompanied by a loss of sensation and voluntary motion, but does not recollect what followed.

Nitrous oxide is one of the most remarkable gases with which we are acquainted. It is a transparent, colourless gas, like air, easily prepared by heating nitrate of ammonia; it has a sweetish taste and a faint odour. It has sometimes been called "laughing-gas," on account of its singular property of inducing involuntary laughter in some who inhale it. This gas cannot be breathed for more than a short time, because its peculiar action on the nervous system soon paralyzes the voluntary muscles of the mouth, which, accordingly, cease to grasp the tube of the apparatus, and common air enters the lungs. An animal confined in nitrous oxide gas soon dies after exhibiting symptoms of excitement. When inhaled by man, it first produces a sensation of warmth in the chest, which warmth soon spreads to the extremities, then follows paralysis of the muscles of the mouth, which puts a stop to the further breathing of it. After a short period of quiet or stupor, the patient becomes excited—laughs, sings, dances, &c. In the course of a minute or two, all these effects pass off suddenly, and he returns to full consciousness with a bewildered stare, having no recollection, or a very confused one, of what has passed. It is, in fact, a true case of somnambulism, momentarily produced. But, in some instances, this period of excitement does not manifest itself, or is only of very short duration, and then comes on a kind of stupor and a complete state of anæsthesia. But it is only with patients who are very sensitive to the action of the gas that this state of insensibility to pain can be produced. The late Dr. Gregory, of Edinburgh University, made several experiments with nitrous oxide, by which he has shown that its action upon the economy is precisely similar to that of ether or chloroform, though it cannot be taken by most patients in sufficient quantity (owing to the paralysis of the muscles of the mouth) to procure complete anæsthesia.

Forty years after Davy's experiments, in 1844, Horace Wells, a surgeon-dentist of Connecticut (North America), applied nitrous oxide to tooth-drawing. The first operation was made upon himself; and, when his senses returned, he exclaimed: "This is, indeed, a new era in tooth-drawing!" He afterwards practised this mode of producing anæsthesia for some time, with considerable success. But, unfortunately, in some experiments at Boston, he failed completely, and was most wantonly ridiculed by the ignorant. Wells then abandoned his business; and, in 1848, died by his own hand. In that same year, however, a medical practitioner at Boston, Dr. Bigelow, made some very serious operations whilst the patients were under the influence of nitrous oxide. The inhalations usually occupied about six minutes, and produced complete insensibility.

Such was the state of things when Mr. Morton and Dr. Jackson, of Boston, discovered the anæsthetic properties of a substance then called "*Chloric ether.*" Morton, who had been a pupil of Wells, had already used nitrous oxide; and it was known, as early as 1818, that this "chloric ether," when inhaled, was capable of producing similar effects to those of nitrous oxide. Thinking that "chloric ether" could be more easily administered than the gas, Morton made an experiment to this effect upon himself, on the 30th of September, 1846, and succeeding in rendering himself completely unconscious for eight or nine minutes. He soon afterwards extracted teeth from patients placed under the influence of this new anæsthetic; and, on the 16th of October, 1846, he administered the volatile liquid to patients about to undergo surgical operations, in the Massachusetts General Hospital.

Morton withheld his discovery, calling the sleep-producing substance "Letheon;" but its peculiar odour led Dr. Bigelow to try the effects of common ether (sulphuric ether), and, finding that it acted precisely like the "Letheon," he immediately made known his discovery. The American papers, however, criticised it unjustly for some time; but all the absurdities asserted against this valuable discovery were exposed when Dr. Bigelow published his work "On Ether and Chloroform," in 1848.

In London, ether was soon experimented with by Dr. Booth, Mr. Liston, and several others. Professor Simpson was at this time in London, and, procuring one of the best inhaling apparatus, he proceeded to Edinburgh, where he employed ether in the treatment of *accouchements*. Soon after this, Drs. Velpeau and Roux informed the Academy of Medicine at Paris that the discovery of the anæsthetic properties of ether was a glorious conquest for humanity.

Thus ether,—which was known to Raymond Lully in the thirteenth century, and to Basil Valentine in the fifteenth, and which Valerius Cordus carefully described how to make, in 1540, calling it *Oleum Vitrioli dulce*,—was only applied to produce insensibility to pain about the middle of the nineteenth century.

It is, perhaps, as curious that the so-called "chloric ether," mentioned above, was nothing less than impure *chloroform.* Mr. Jacob Bell, of London, it appears, was the first to procure it in a pure state, and demonstrated anew its wonderful anæsthetic properties. As early as 1831, Dr. Gutherie, an American chemist, had shown that this substance is procured when spirit of wine is distilled with chloride of lime. But its true chemical composition, which had puzzled Professors Silliman, Liebig, and Soubeiran, was finally determined by Professor Dumas, of Paris, in 1832.

On the 8th of March, 1847, M. Flourens stated, at the Paris Academy of Sciences, that he had experimented with chloroform upon different animals, and had ascertained that it invariably produced insensibility; but he concluded that its action was too dangerous to be applied to man. However, in November of the same year, Professor Simpson, of Edinburgh, applied chloroform, for the first time, to annul the pains of labour, and it has since completely dethroned ether in surgical operations.*

Dr. Gregory, of Edinburgh, afterwards showed that the action of ether and chloroform is precisely similar to that of nitrous oxide gas. When either of the two former is inhaled in insufficient quantity, the patients are given to laughing, dancing, &c., as if they had respired a dose of "laughing-gas."

It is certainly wonderful, when we reflect upon the fact, that these volatile liquids, whilst rendering us insensible to pain, cause the patient to experience pleasant sensations whilst under the knife of the surgeon. Before referring to any other means of rendering man insensible to suffering, let us take a rapid glance at the manner in which these remarkable anæsthetics act upon the system.

Under the influence of chloroform and ether, the nervous centres lose their powers in regular succession. This is not only an interesting physiological fact, but also a practical point of great importance. First, the cerebral lobes lose their influence, and consciousness disappears entirely. Next, the cerebellum loses its power of regulating locomotion. Next, the spinal cord becomes incapable of producing sensation and of originating motion; but the *medulla oblongata* (that portion of the spinal cord which enters the brain), which presides over respiration, still retains its functions. Next, the *medulla oblongata* is affected; when this occurs breathing ceases, and death is near; but, even yet, the ganglionic nerves of the sympathetic system perform their functions, and the heart and intestines continue to move for a time, often with vigour.

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* Ether has often been applied with success to subdue intoxication by wine, as we see the betel-nut employed by the Eastern princes to dispel the effects of *haschish*; after inhaling a little ether vapour, the intoxicated person generally recovers his senses. Ammonia acts in a similar manner.

It is thus seen that when anæsthetic vapours are inhaled the different nervous centres lose their powers in the *inverse* order to their *essentialness* to life; the functions of the sympathetic nerves ceasing last of all, and the heart and womb retaining for a time, therefore, their contractile power during states of anæsthesia, so deep as not only to involve the annihilation of consciousness and sensibility, but also of respiration. In order to render a patient insensible to the most severe surgical operations, it is never necessary to proceed further than the third stage of anæsthesia; in child-birth still less is required, and the patient may be kept on the borders of consciousness, or be conscious even during the whole time.

Here, then, in a few words, is the explanation of these wonderful phenomena.

In the human body exist, as I stated before, different systems of nerves, and the art of producing anæsthesia consists in allowing one system to work as usual whilst the other systems are under the influence of sleep. The nerves of motion and of sensibility are made to sleep, whilst the nerves of organic life continue their functions. We are now enabled to appreciate these wonderful discoveries, and to admire the marvellous arrangement of the nervous system. The problem of depriving man of sensibility and motion, without impeding respiration, circulation, digestion, or, in other terms, of depriving him of his faculty of moving and of feeling pain, without depriving him of life, has been solved. During anæsthesia, then, man lives like a plant—his animal faculties are taken from him for a time.

Since the discovery of chloroform, several substances have been found to have a similar wonderful action upon the nervous system. Among them are two chemical products, called *Amylen* and *Acetone*.

Amylen, a peculiar volatile liquid, obtained from impure potato spirit, was first administered by Dr. Snow, at King's College Hospital, London, in November, 1846; and he continued to use it until July, 1857. During this period, 238 persons were operated upon during anæsthesia produced by amylen, out of which number only two deaths occurred. It was afterwards used in France; but I do not know that it possesses any advantage over chloroform.

In 1859, Dr. Kidd proposed the use of Acetone (a volatile liquid, produced by distilling acetate of lime, and which has long been known to chemists) as a powerful anæsthetic. Its agreeable odour, which resembled somewhat essence of mint or of quince, appeared to recommend it. Its anæsthetic action is less durable than that of chloroform, but, at the same time, it acts very rapidly. Its principal advantage was stated to reside in the fact that it can be mixed with water in any proportion, so that the dose can be regulated at will; it can, moreover, be employed in damp, warm sponges, and is not liable to decompose by keeping.

Of late years, *cold* has been applied in some cases to induce local anæsthesia. Dr. John Arnold has advocated the induction of insensibility by freezing the part to be operated upon. This is based upon the fact that the nerves of sensibility cannot perform their functions below a certain temperature. Thus it is that travellers on the summits of high mountains or in the Arctic regions are apt to lose their noses, the nerves of the frost-bitten part being benumbed by the cold; gangrene sets in without the sufferer being aware of it.

Local anæsthesia has also been produced by the simultaneous actions of electricity and a narcotic. Some experiments were made upon this subject by Dr. Richardson, in 1859. This method of proceeding is very simple:—Upon the part to be operated a powerful narcotic is applied, and upon the narcotic mixture is placed a flat metallic disc communicating with the positive pole of a Bunsen's or Grove's battery; the negative pole being applied to some other portion of the patient's body, at a convenient distance from the other pole. The battery being put in action, that part of the patient's body comprised between the two poles soon becomes insensible to pain.

Dr. Richardson has also made the curious discovery that the fumes emitted by burning the common Puff-ball Fungus (*Lycoperdon proteus*), when inhaled, produce anæsthesia in a similar manner to chloroform and ether. The fumes of this fungus have been for some time employed with advantage to stupefy bees before taking their honey; it causes no injury to these useful insects. This fact probably led Dr. Richardson to try its effects upon other animals, and, lastly, upon man; when he arrived at the conclusion that the fumes given off by the common puff-ball, when this fungus is burnt upon a hot shovel, possess anæsthetic properties in a high degree.

Carbonic acid gas has been shown quite recently, by Dr. Ozanam, of Paris, to be capable of inducing anæsthesia like chloroform, &c. Indeed, its peculiar stupefying action is frequently experienced by the French cooks, in whose kitchens wood-charcoal is used in small open grates; and by the inmates of counting-houses and warehouses, where ventilation is generally bad. The effects of this deleterious gas upon dogs is frequently shown to travellers near Naples in the *grotto del Cane*, a cavern where a large quantity of carbonic gas issues from the earth, and from its weight, much greater than that of air, forms a thick stratum of suffocating gas upon the floor of the cavern. When a man enters, his head and shoulders rise above the stratum of gas, and he breathes pure air; but when a dog is introduced, his head and body plunge completely into the carbonic acid gas, and he soon falls down, suffocated. The animal is then removed by the guide, laid upon the grass outside; and, in a short time, recovers.

Dr. Ozanam has shown that this suffocation by carbonic acid, when produced properly, affects a patient like chloroform, ether, or nitrous oxide, and can be made available in surgical operations. Indeed, he considers that carbonic acid has certain advantages over chloroform, and that it is less dangerous than the latter.

But of all the means hitherto employed to render man perfectly insensible to pain, the most curious, perhaps, is that called *Hypnotism* or *Braidism*, discovered many years ago by the late Dr. Braid, of Manchester, and practised successfully by him in England. It consists in placing some object, such as a cork or a piece of polished metal, at a short distance from the forehead of the patient, and requesting him to fix his eyes steadfastly upon it. After some time, which varies from a few minutes to half an hour or so, according to the constitution of the individual, the patient's eyes seem riveted upon the object in question, and for some moments he remains thus, without once closing them; they then suddenly close, and the patient falls into what is termed the hypnotic state, a kind of somnambulism similar to mesmerism. Consciousness has disappeared, and complete insensibility to pain has ensued.

Braid's discovery seems to have been abandoned for some time past by the medical world, but was occasionally put in practice by lecturers on the so-called "electro-biology," &c. Lately, however, it has been taken up again in Paris, by M. Paul Broca, surgeon to one of the hospitals of that city; and Dr. Braid just lived long enough to hear of his method of producing anæsthesia meeting with singular success in the hands of M. Broca. One of the first results obtained by the latter was made known a year or so ago at the *Académie de Médecine*. It was the case of a woman who had repeatedly refused to be operated upon for a large tumour. At length, M. Broca induced anæsthesia by causing the patient to fix her eyes upon a metallic disc which he held above her forehead. In about a quarter of an hour, a state of complete insensibility supervened, and the operation was performed. On returning to her senses, the poor woman would not believe that the operation had indeed taken place whilst she was under the influence of sleep.

BARMOUTH.

BY THE EDITOR.

"VACATION TOURISTS" make it their business, once a year, to strain every nerve in order to reach the remotest corners of the earth, to visit some unexplored or imperfectly-known region, and accomplish the journey home, during the period called "the vacation." That the last is a somewhat indefinite term is obvious, from the fact that it enables one gentleman to set foot on the Fiji Islands; another, to admire the scenery of the river Amazon; a third, to compass a nine weeks' tour in Canada; and a fourth, to sun himself on the banks of the Niger, and in other portions of tropical Africa! How these feats can be accomplished within a period which we have usually supposed to be limited to five or six weeks, we are at a loss to understand, and it is not our business to institute an inquiry; but, however it may be managed, we fear that, after the revelations of those hardy travellers who brave the perils of the ocean wilds and mountain avalanches, the burning desert and the knife of the savage, in order to serve up a palatable dish of adventures for their readers at home; after a perusal of the narratives of these bold adventurers, we say, there can be little hope that our readers will find much to interest them in the few notes taken during a "vacation tour in Wales," comprising a sojourn of ten or twelve days at a quiet little fishing town, and a series of short excursions in its vicinity.

We shall take courage notwithstanding; conscious that if we are unable to satisfy that craving after the marvellous, which can only be appeased by stories of hair-breadth escapes from such dangers as we have just referred to, yet we have the advantage of being able to direct the attention of our readers to scenes of beauty and interest lying at their own doors, and to speak to them of pleasures, in every way rational and desirable, which they may themselves enjoy, instead of receiving them, with or without modifications, at the hands of others, and participating in them only in imagination. For it matters little to what class or section of society the reader belongs; be he rich or poor, sick, careworn, or ripe for sport and adventure; be he angler, botanist, conchologist, geologist, palæontologist, pteridologist, ornithologist; indeed, if he be devoted to any or many branches of science, commencing with archæology and ending with zoology—or only a lover of the grand and beautiful in Nature—he may indulge to the full in his favourite pursuit within ten miles of the modest little fishing town which forms the subject of these pages.

The archæologist will find relics of antiquity connected with every period of past history. In the town itself is an old building, rendered interesting by its association with incidents in English history in the fifteenth century.

Llanaber Church, a beautiful little edifice, distant about two miles from Barmouth, and still used for divine worship, is supposed to have been built about the thirteenth century, and abounds in features of archæological interest; so, also, does the old Elizabethan mansion of Cors-y-gedol, about five miles distant. These, along with Harlech Castle, Cymmer Abbey, &c., are associated with the history and habits of the Middle Ages; whilst there is hardly a lake, stream, or mountain slope which does not, either by traditions connected with it or actual remains, carry the tourist back to the Roman occupation, the Druidical age, or to the still more remote eras of mythology.

So much for the archæologist, now for the botanist.

Does he desire to study and collect wild flowers? Then, we may venture to promise him (without at all referring to their glowing colours, which rivet the attention of the traveller so that he can barely find time to admire the grandeur of the surrounding scenery) that he will meet with numbers and variety in the valleys, on the hills, or by the wayside, which will serve to occupy his attention during many a protracted ramble. Forest-trees he will also find in great diversity and splendour; whilst of ferns, mosses, lichens, fungi, &c., the name is legion; and many ferns present themselves of extreme rarity.

Of all these plants a list, prepared by a talented botanist in the neighbourhood,* has been appended to the little handbook before us;† and there are few localities, in England or elsewhere, which yield such treasures of plant-life as do these hills and valleys and rugged cliffs.

The marine zoologist will meet but little to interest him on the shores of Cardigan Bay, at least not within a convenient walking distance of Barmouth; but the ornithologist and entomologist will find, both on the shores and inland, many interesting birds and insects.

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* Mr. J. Pughe, F.R.C.S., Aberdovey.

† The printed "Guide to Barmouth" is published by Mr. D. Jones, Bookseller, Barmouth. The most experienced guide living at Barmouth is a person called Hugh Richards—a good sportsman and a useful companion to the archæologist.

To the shell-collector more especially, is this a locality of deep interest, for, about seven miles from Barmouth, in the direction of Harlech, there is a small tongue of land jutting into the sea, called Mochres, where shells of great rarity, both univalve and bivalve, are to be met with on the beach at low water, more particularly after tempestuous weather.*

And now, what have we for the geologist and mineralogist? Judging from the ecstasies of two learned professors from the metropolis, with whom we journeyed a few miles through this lovely district, as well as from our own observation, we should say that there are few parts of Britain which afford so many opportunities for the study of these subjects as do the hills and rocks of this neighbourhood.

The following extracts concerning the geology of Cader Idris will convey to the reader some idea of the varied character of the strata in this district:—

"GEOLOGY.—It consists of silicious porphyry, quartz, and schorl, and is surrounded by slaty hills. Evidences of the volcanic character of the mountain are abundant. Numerous specimens of lava, pumice, and other volcanic products, have been discovered on the sides and base of the mountain. Columnar crystals of basalt are scattered in profusion about the summit and on some of the inferior cliffs, and particularly on one side, there are vast beds of porous stone, bearing evident marks of strong ignition and vitrification—some reduced to the state of slag, and others having the cellular appearance and lightness of pumice."—*Black's Guide*, p. 121.

"The slope of Cader, on the Talyllyn side, above Llynycae, is an igneous rock, principally composed of amygdaloidal green-stone, and under are masses of felspathic trap and long lines of green-stone, interbedded with altered slate, forming the steep north cliff of the mountain, and overlooking the high valley between the cliff and Llynygader, which itself is formed almost entirely of felspathic ash and conglomerate, with interbedded lines of green-stone—the whole dipping under the igneous rocks of the cliffs. Lingular flags underlie these."—*Ramsay.*

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* For the guidance of conchologists visiting this interesting locality, we may add that Mochres may be approached from two points, namely, from Llanduwe, a church and inn, situated rather over four miles on the road from Barmouth to Harlech, or from Llanbedr, a considerable village, three or four miles nearer to Harlech, on the same road. Although a little may be saved in the distance, by approaching it from the first-named place, yet, on account of the tedious walk across a dreary moor which must be traversed, as well as the difficulty sometimes experienced in crossing to Mochres from the mainland by this route, we strongly recommend the tourist to proceed along the beautiful coast-road to the village last-named (Llanbedr), which is close to the peninsula, and from which he may reach the shell-covered beach in a few minutes without any difficulty.

Amongst the numerous mineral products extracted from the soil in various parts of the neighbourhood, the most conspicuous are slate, copper, lead, and gold; and, as reference has already been made to the last-named precious metal in a recent number of this periodical, we shall now add a few details on the subject, which may, perhaps, be interesting to our readers.

In his paper on the Gold Mines of this district, our contributor more than once mentioned the name of Mr. Readwin, to whose enterprise and scientific knowledge this country is indebted for the new mine of wealth which is being laid open in these our home-diggings.*

During our recent visit, we were so fortunate as to meet that gentleman, who is largely interested in several of the most important mines in the neighbourhood; and one of these, the Garthgill mine, we were permitted, through his kindness, to inspect.

Let us narrate the details of our visit.

Having received a note from Mr. Readwin, stating that he would be at the Garthgill mine, which is situated about halfway between Barmouth and Dolgelly, not far from the coach-road, between one and two o'clock in the afternoon, we started from the former place on a magnificent July morning, at about half-past eleven; and, after a smart five-mile walk, arrived at the "Halfway House," a little roadside inn, at a place called Pont Ddu, which is distant about one mile from the workings of the Garthgill mine.

A word *en passant* concerning this same walk of five miles. The road runs along the northern bank of the river, or, more properly speaking, the estuary of the Mawddach, deviating slightly, here and there, from the upward course of the stream; and, although we have visited many a beautiful scene, in Britain as well as abroad, we must confess that we have never met with anything to surpass this one. We see it before us in imagination as we write. Facing us, through a break in the trees, are the towering heights of Cader, on the opposite side of the river. To the right we have the boundless expanse of ocean peering through the bold headlands at the mouth of the estuary. To the left, the Mawddach, vying in beauty with the choicest portions of the Rhine, and presenting the appearance of a series of beautiful lakes through the windings of the stream amongst the mountains; whilst on all sides are ranges of hills, the slopes of some being fertile meadows, others bare, rugged, and precipitous, and others, again, concealed from the eye by the plantations of pine and fir, reaching from base to summit.

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* "The English California," by G. P. Bevan. No. IV. POPULAR SCIENCE REVIEW.

By the wayside are walls and hedges glowing with all the colours of the rainbow. Foxgloves of intense purple, wild roses of the deepest pink, with here and there wild geraniums, wild strawberries, and rasps; and as to the ferns, we feel, when we stoop to pluck a frond, to be used for driving off the troublesome flies, as though we were committing a desecration upon nature, in thus deforming the graceful cluster which shoots its arching stems on every side.

But we must quit this lovely scene, only, however, to approach another almost as beautiful. Having partaken of luncheon at the "Half-way House," a meal rendered most enjoyable by the healthful exercise of a rapid walk amongst these glorious scenes, we hastened onwards, and soon arrived at a large water-wheel, a mile beyond Pont Ddu, which is used for grinding the copper ore extracted from a neighbouring mine. Here we diverged from the main road, and, under the guidance of a blacksmith, who has a smithy hard by, and who was unable to speak a word of "Sassenach" (Saxon, or English), whilst we are equally well versed in "Cymraeg" (Cambrian, or Welsh), we found the "engine-house" of the Garthgill Mine. And here another beautiful scene presented itself to our gaze.

In the mining districts, the "Black Country" of Northumberland, Lancashire, and Staffordshire, nature appears to don sackcloth and ashes; to mourn, as it were, over the robberies hourly perpetrated in her domains. But here, amongst these lovely hills, she welcomes the enterprising miner, and tempts him to commence his operations by laying her treasures at his feet, and holding out to him every inducement that her charms can afford.

On the one hand, we find nought but smoke and arid desolation; and, if some unsuspecting plant, some blade of grass or tender floweret, should venture to extrude itself above the surface, the noxious gases of the furnace, factory, or mine, at once deprive it of its tints, and cause it soon to droop and die for very shame. Here, on the other hand, the elements and nature co-operate with man. The rushing waterfall, bubbling and gurgling amongst the rocks, stops in its headlong course, and, flowing gently through an artificial duct, assists to turn the wheel, and work the pestles of the miner; whilst the clear stream below serves at once to slake his thirst, to lave and cool his heated brow, and cleanse his ore from dross and from impurities.

'Twas such a scene as this that we encountered here.

From the "engine-house" (to be presently described), we continued to climb up the hill, accompanied now by the overlooker of the mine, and, after traversing a beautiful meadow on the mountain slope, where they were busy getting in the hay, and passing more than one working, at which operations had just been commenced, we suddenly found ourselves before the chief working or lode; not a very imposing, but still an interesting, excavation.

It is a small tunnel driven into the hill-side. Its height is about eight or ten feet, and its width barely five; and at the entrance we found several heaps of the auriferous quartz.

Entering the tunnel, we observed that the superincumbent rock and earth were supported by props and joists of wood; and, after penetrating about twenty or thirty yards, we found ourselves with the miners, who were busily engaged with pickaxe and gunpowder, procuring the gold-charged mineral, which, by the light of their candles, glistens with the precious metal it contains.

But it is a cold, damp burrow, this treasure-yielding vault! Through the grey rock the wet trickles as in some cave of stalactite, and under-foot we find a pool of water.

The miners had just finished procuring a load of the quartz, and were boring for a fresh blast. After watching them for a time, we retraced our steps, and once more emerged from the damp chill cavern into the genial sunshine, and feasted our eyes upon the glorious hills and valleys of the Mawddach.

Arrived once more at the "engine-house," a little wooden shed containing the apparatus used for grinding the quartz, we met the enterprising owner of the mine, who described to us the process and machinery by which the precious metal is extracted from the crude mineral.

We shall, however, refrain from employing the technical phraseology used by our instructor, but shall seek to convey the information after our own fashion.

Just let the reader join us whilst we indulge in a stretch of the imagination. He must suppose that our skilful companion, the proprietor of the mine, who knows so well how to conjure up the treasures from the bosom of these hills, is also able, through some potent spell, to summon the presiding Genius of the place (one of those Welsh giants, in whom the country people still believe, and whose footsteps they will show you, thirty feet apart*), and having done so, places before him a pestle and mortar, of proportions suited to his strength, and by his side a heap of auriferous quartz, with a quantity of quicksilver, bidding him grind the ore, whilst an attendant sprite is pouring a continuous stream of water on the triturated mass.

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* On the coach-road between Beddgelert and Carnarvon, the impress of one of the feet of a giant has been painted on the top of a rock on one side of the road, and that of the other foot on the opposite side, distant about thirty feet.

This is really what Mr. Readwin has contrived to do.

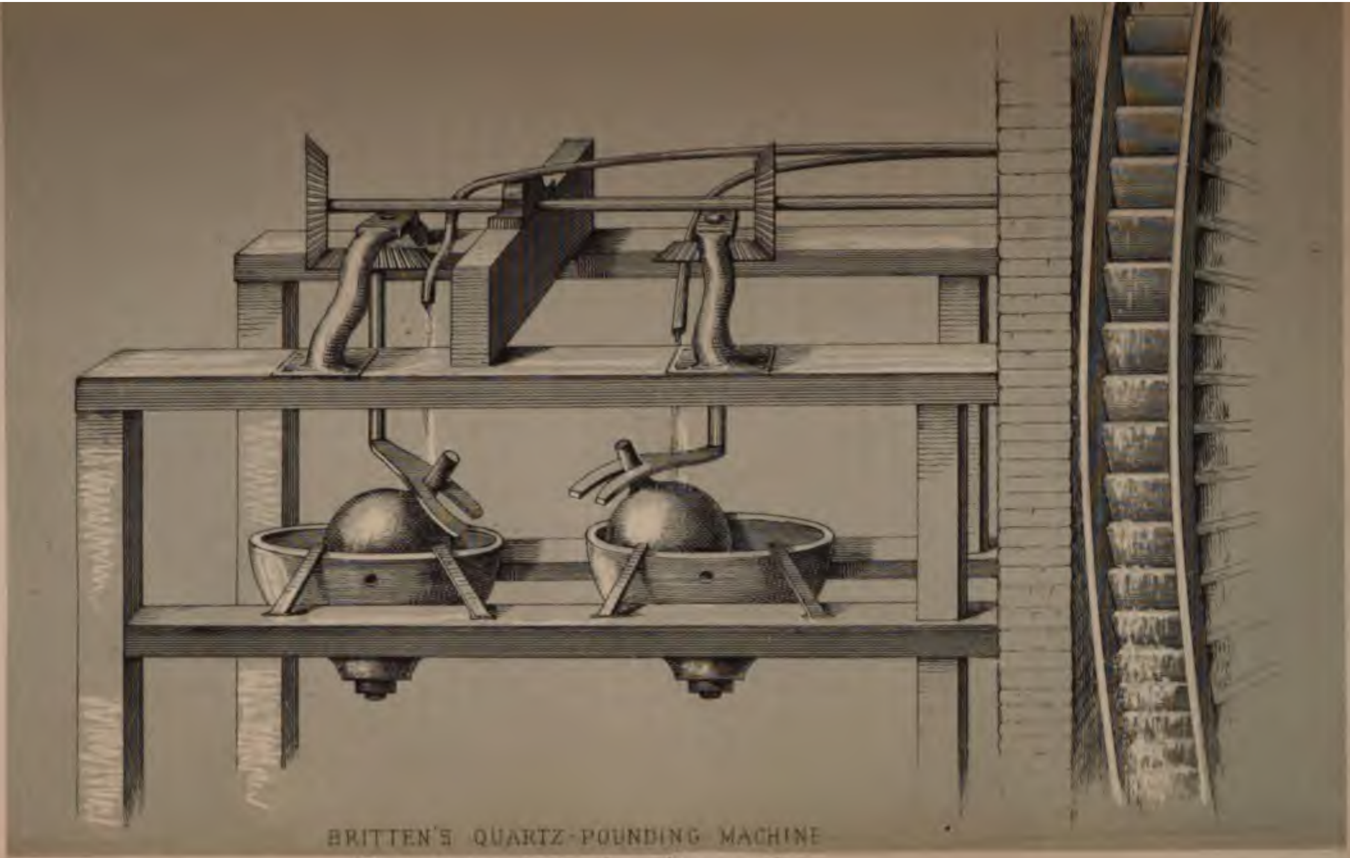
His "Genius" is the lovely waterfall which excited our admiration, and which is formed by the stream as it flows past the engine-house.

Causing a portion of the water to diverge, he lets it flow along a wooden conduit that leads it to a little water-wheel, which is thus set in motion. This wheel turns a horizontal shaft or axle in the engine-shed, and, by means of two vertical cog-wheels attached to the shaft, and two other horizontal ones, into which these work, two smaller vertical shafts are set in motion, and to these are affixed the arms, which cause the grinders or pestles to revolve in the mortars containing the quartz. This is effected much after the manner in which a druggist's apprentice pounds drugs with a large pestle and mortar. The arms attached to the vertical shaft are of iron, and the reader may form an idea of their shape and mode of operation, if he turns the palm of his hands downwards, doubling his thumb and two last fingers underneath, protrudes his first and second fingers, and slightly separates them, lowering the points. These two fingers will then represent the "arms." Let him now suppose that his fingers can be made to revolve horizontally, and that they carry round with them a pestle, which is held between them, but allowed to roll freely against the sides of a mortar, in which it works, and he will thus imitate the grinding or pounding process here employed. (See Plate IV.) The pestle is shaped like a peg-top, with the pointed end downwards, and weighs about 2 cwt.; and the mortar is a vessel of cast iron, of proportionate size and strength; of a suitable form internally, and externally a hemisphere. The quartz is first broken as fine as the hammer can reduce it. It is then placed, along with mercury, in the mortar, and a little stream of water is allowed to trickle continually through a siphon upon the triturated mass. The gold contained in the quartz is taken up by the mercury as the trituration proceeds, and a lump of amalgam sinks to the bottom of the mortar, and is taken out through an opening closed by a plug. It is heated in an iron retort over a furnace, the mercury driven off, and the residue is pure gold, worth about £3 an ounce.

In some cases, the gold is visible in the quartz, and Mr. Readwin showed us a piece of the latter, so charged with it, that he valued it (the crude mineral) at £1,200 per ton; in others, it is scarcely to be detected with the aid of a pocket-lens, being disseminated in fine granules throughout the matrix.

There are other processes by which the gold is extracted

Plate IV



BRITTEN'S QUARTZ-POUNDING MACHINE

(For grinding, washing and amalgamating.)

at Garthgill by J.S.

W. West Lith.

from the quartz on these hills, but this one appeared to us so simple that we describe it in preference to any other for the benefit of our readers, who must permit us now to conclude our visit to the gold-mine, and will, we hope, return with us, more expeditiously than we came, to the centre of our excursions—Barmouth.*

Enough has, we trust, been said to show that this place and its vicinity abound in features of interest to the man of science, and a great deal more might be added to the same effect; but, possibly, there may be amongst our readers some who would feel a desire to visit it, as we did, for relaxation and rest from those very pursuits which may be here so successfully followed; and to such we will, therefore, address a few words in conclusion.

This quiet little fishing town, nay, we need not hesitate to call it village, for it contains at present only 1,200 inhabitants, certainly offers no attractions to the man or woman of fashion. There is no promenade except the beach extending for miles round Cardigan Bay; no Spa; no morning or evening dress.

If the frequenter of the parks or ball-rooms of the city desire to meet fashionably-attired ladies, we advise him to seek these and similar attractions at Scarbro', Brighton, or some other equally fashionable and well-frequented watering-place, but not to embarrass and disturb the tranquillity of the students, artists, and overworked men of business, who take refuge here, with their wives and children, from the noise and bustle of the busy, struggling world; and who, bringing with them their oldest garments, wear out these instead of the bodily frame which they cover; and take away with them bronzed faces, fresh roses in their cheeks, an increase of corporeal substance, light hearts, and renovated spirits to enable them to enter once more into the battle of life.

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* The account here given of the gold-extracting process is necessarily imperfect and superficial; but such of our readers as desire more detailed information, on that and kindred subjects, are referred to the following printed papers:—

"On the Occurrence of Gold in Merionethshire," by T. A. Readwin, F.G.S. Read before the British Association, 1861. Published by A. Ireland & Co., "Examiner" Office, Manchester.

"The Gold Discoveries in Merionethshire, and a Mode for its Economic Extraction," by T. A. Readwin, F.G.S. Same publishers.

"List of Gold Ores from Merionethshire," exhibited at the International Exhibition, 1862. With detailed description, by T. A. Readwin. Same publishers.

"The Geological Structure of Merionethshire and Caernarvonshire," by Professor Ramsay, F.R.S., &c. Reynolds & Co., London.

The *Manchester Examiner and Times*, of Tuesday, July 29, 1862.

Mr. Readwin informs us that *two* such machines as we have described and sketched are in constant use at a mine near the "Garthgill" (the Clogau), and that they extract *weekly* 140 ounces of gold from 7 cwt. of quartz.

If, however, there be any one who can admire a quaint little seaport town, standing on the sea-beach, at the foot and on the incline of a precipitous rock whose summit may be 1,000 feet above the sea-level; a town consisting of neat grey stone houses, so built upon the precipitous cliff that the inhabitants of one set of houses look over the chimneys of another row beneath;—if he can find enjoyment in rambling five or six (or as many more) miles along the broad sands or beautiful coast road which extends in either direction along the Bay of Cardigan; can appreciate a sail, row, or ramble amongst the hills and valleys, and wishes to realize the beauties of the Rhine without quitting his native land, or, lastly, if he can rouse himself sufficiently to scale the sides of glorious Cader, as we did one fine summer afternoon, rambling by the way through wooded glens, rich in trees and ferns and flowering shrubs, and by the side of rushing waterfalls, climbing rugged steeps, sweeping round magnificent hill-sides, stopping to ponder over the vestiges of ancient rule in Britain—man's handiwork—or to admire the grand operations of Nature as exhibited in volcanic action, in pumice and heaps of slag-like stones and columnar basalt set on end in architectural order, treading elastic heath and breathing its invigorating atmosphere; if he can find delight in a constantly-extending landscape, hill after hill, lake after lake, town after town opening to the sight; clouds spread out like a sea beneath, or sweeping past him like volumes of smoke from a cannon's mouth, or floating gently, as snowy fleeces, overhead, until at length he has risen so high above the earth that he appears to have reached some new celestial region, from which all beneath looks small and insignificant, whilst the beholder feels himself raised high above all earthly passions and sensations;—if, we say, any of our readers can appreciate such delights as these, then let them speculate upon and anticipate now, visit and enjoy hereafter, and recollect, as we shall do, with life-long remembrance, a vacation trip in North Wales, a sojourn at the little town of Barmouth, at the entrance of the river Mawddach, in Merionethshire, and many a pleasant health-reviving ramble through its valleys and across its mountain ranges.

ON THE APPLICATION OF SCIENCE TO ELECTRO-PLATE MANUFACTURES.

PART II.

THE success of an important enterprise has frequently depended upon an apparently trivial circumstance, and it was even so with the important process of silver electro-plating in the early period of its development. In the year 1838, Messrs. G. R. & H. Elkington were engaged, commercially, in coating military and other metal ornaments with gold and silver, by immersing them in various solutions of those metals, some of which were composed of ferrocyanide of potassium, and also carbonate of potash, with the oxides of gold and silver dissolved in them.

By this process of simple immersion, although the action was electrical, the articles received only an extremely thin film or coating of the precious metals, and it was highly desirable that the thickness should be considerably increased, on account of the greater degree of durability required.

About this period, Professor Jacobi, of St. Petersburg (October, 1838), and Mr. Spencer, of Liverpool (May, 1839), published their processes of electrotype for copying engraved plates in copper by separate currents of electricity, by means of which a firm coating of copper, of considerable thickness, could be readily obtained. From the moment that this method of obtaining *thick* deposits of firm copper by means of a *separate* electric current was made known, Mr. John Wright, a surgeon of Birmingham, and Mr. Alexander Parkes, a modeller and experimentalist, in the employ of Messrs. Elkington, were constantly engaged in experiments, to obtain thick deposits of silver and gold by similar means. A great variety of liquids were tried for the purpose, but all the solutions of gold and silver operated upon gave only a thin deposit of firm metal, which, as it increased in thickness, became loose in aggregation, and assumed the character of a dark-coloured or black metallic powder, completely useless for the purpose required.

At this particular juncture, Mr. Wright met with the following passage in Scheele's "Chemical Essay" (pages 405 and 406). Speaking of the solubility of the oxides and cyanides of gold, silver, and copper, it says, that "if after these calces" (*i. e.*, the cyanides or ferrocyanides of gold and silver) "have been precipitated, a sufficient quantity of precipitating liquor be added, in order to redissolve them, the solution remains clear in the open air, and in this state the aerial acid" (*i. e.*, the carbonic acid of the atmosphere) "does not precipitate the metallic calx."

This liquid, "the precipitating liquor," is obtained by burning dried blood with potash in an iron vessel, cooling the melted product, and dissolving out its soluble portion by water; the resulting solution contains cyanide and ferrocyanide of potassium, the latter of which is commonly known as "yellow prussiate of potash."

Mr. Wright had been working during several months, expressly to obtain a thick deposit of silver, with the aid of a separate electric current, before he met with the above passage. He then took a solution composed of chloride of silver, dissolved in an aqueous solution of ferrocyanide of potassium, and succeeded in obtaining what had never been obtained before,—a *thick* deposit or coating of *firm* silver by electrolytic action.

The first article that received the successful coating was a small vase, which was coated at Mr. Wright's residence, and the next was a figure of a small kid. The mode of proceeding adopted by him in these cases, was to place the article in the silver solution contained in a porous vessel (a common garden-pot), immerse the porous cell in an outer vessel containing dilute sulphuric acid, place a cylinder of sheet-zinc around the porous vessel in the dilute acid, and connect it by means of a copper wire with the article to be coated; the electrical action then commenced, and the article gradually acquired a thick coating of silver: this method is commonly known as the "single cell" process.* It was about a month after this when a solution of actual cyanide of silver and potassium, the substance now universally used for electroplating, was first employed by Mr. Wright for the purpose, although cyanides, in several forms, had been used both for coppering and silvering by simple immersion, without the aid of a battery or zinc, about sixteen months previously.

The above-mentioned successful results were immediately submitted to Messrs. Elkington, who made arrangements with Mr. Wright for the security of the discovery and invention, and patented it on March 25th, 1840; this patent was the basis of all successful electro-silver-plating and gilding. A handsome remuneration was made to Mr. Wright by this firm for his invention, and an annuity paid to his widow (afterwards the wife of Mr. Cammell, of Sheffield), after his death. A separate battery, to generate the electric current, was not employed until January, 1841, nearly a year after the date of the patent; and, in the early stages of the process, the silver solution was employed hot; now it is always used cold. Nickel silver was always the substance employed as a base for receiving the deposit from the earliest period of electro-silver-plating, or at least soon after the date of Mr. Wright's patent. The edges of articles are made of the best quality of nickel silver, which is very white and very hard, suitable for resisting friction, whilst the body part, or mass of the article, is made of a commoner quality, not only because it is less expensive, but also because it is worked more easily.

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* See Plate V. fig. 1, and explanation at end of article.

Electro-deposition of the precious metals was *theoretically* accomplished long before cyanide of potassium was known; as early as the year 1805, Brugnatelli "gilt, in a complete manner, two large silver medals, by bringing them into communication, by means of a steel wire, with the negative pole of a voltaic pile, and keeping them, one after the other, immersed in ammoniuret of gold, newly made and well saturated." We should therefore not condemn theoretical science, because we are not able, even with fair and persevering trial, to apply it to any useful purpose, but *wait patiently* until circumstances ripen for its application. Many discoveries and inventions which are inapplicable in one state of knowledge, become applicable by the progress of science and art; the idea of electro-gilding, first attempted in 1805, by means of a solution of ammoniuret of gold, had to await the discovery of cyanide of potassium, in 1815, before it could be practically applied; and the idea of an electric telegraph, first attempted by the aid of frictional electricity, had to abide the development of the voltaic battery, and the discovery of electro-magnetism, before it could be successfully carried out.

A great number of experiments had to be made, and many serious difficulties to be surmounted, before practical and remunerative electro-plating was an accomplished fact. One of the chief difficulties consisted in making the silver adhere firmly to all parts of the underlying metal; this want of adhesion arose partly from the employment of too many cells in the battery, and partly from the use of too strong mercurial solution in preparing the surface, and was eventually overcome by lessening the number of cells, and dipping the previously cleaned articles in a *very weak* solution of mercury immediately before placing them in the plating liquid. If the deposit of silver is not firmly attached to the whole of the surface of the article, it is apt to rise in blisters and peel off when the articles are subjected to the after-process of burnishing. This non-adhesion of the silver was particularly apt to occur with articles made of Britannia metal, and with this particular alloy it was not overcome for several years; it was then effected by first coating the articles with copper, by electro process, in a solution composed of sesquicyanide of copper dissolved in an aqueous solution of cyanide of potassium, a liquid invented by Mr. Wright for the purpose of coppering articles of iron previous to silvering them, and patented in September, 1841. The method now in use for coating Britannia metal is different; it consists in first forming a thin deposit of silver upon the article, by a powerful battery, in a solution containing but little cyanide of silver and much cyanide of potassium, thus transferring the article to the ordinary silver-plating liquid, and completing the deposit therein in the ordinary manner: this process was first employed by Mr. Thomas Fearn, from whom it was purchased by Messrs. Elkington for a considerable sum of money.

Another difficulty arose in a tendency of the deposited silver to assume a granular or semi-crystalline state upon the surface of the articles, especially at their edges, during the process of deposition; this was overcome by employing proper proportions of the ingredients in the plating solution, and carefully adapting the power of the battery to the size of the articles. In addition to these difficulties another was experienced; the articles after being plated and finished, in a few months became much discoloured: this was a consequence of too rapid deposition. And a still more serious difficulty, which required several years to surmont, arose from the opposition of the manufacturers of plated wares of Sheffield to the new method of plating; they objected to take licenses for the new process; but now the electric method is the only one they employ. A dispute also arose between Messrs. Elkington, of Birmingham, and Ruolz, of Paris, the latter having obtained a knowledge of the process and taken out a patent for France a short time before Messrs. Elkington, and a trial at law resulted, in which it was established that Messrs. Elkington were the original patentees of the cyanide of potassium solution, and it was finally settled by a compromise between Messrs. Ruolz and the patentees for the use of the process. In consequence of these and other difficulties, it was at least seven years before it became both practical and remunerative.

In electro-plating the deposited metal spreads as readily over the most elaborately engraved or figured surfaces as over the plainest forms, and in consequence of this property the new process caused a new and great extension of trade in plated articles to spring up, because articles of complicated forms, or with elaborate designs upon them, could not be made by the old method without very great expense. By the new method they were first cast of the requisite shape in German silver, and then coated with the precious metals, whereas by the old plan they required to be made from flat sheets of copper previously plated with silver by fusion; the different parts of a complex figure were first stamped into the requisite forms separately, and then the various pieces soldered together to make the entire figure; and thus a figure which could be made entire in a single piece by the new mode, required to be formed of several or many pieces by the old one, and after a moderate amount of wear the lines where the parts were soldered together became visible, and greatly disfigured the object, and those lines could not again be covered with silver. By the old plan, every portion of a figure which was "undercut," *i.e.* in which the external parts overhung the internal ones, as the mouth or ear of an animal, for example, required to be made of several pieces, whilst by the new method such parts could be made entirely in one piece with the whole figure, and be coated with the precious metals all over, without any seam or joining. A great scope for the extension of beauty and taste in designs of metallic figures and vessels thus commenced, which has gradually extended itself to electro-plated articles of very moderate price, such as tea-pots, coffee-pots, cream-jugs, sugar-basins, &c., the base of which consists of Britannia metal; and the electro process has thus enabled persons of limited incomes to enjoy the use of articles of elegant design previously inaccessible even to the wealthy.

The next event of importance in the history of electro-plating consisted in the application of magneto-electricity instead of electricity from a voltaic-battery to depositing purposes. In August, 1842, J. S. Woolrich took out a patent for the use of a magneto-electric machine instead of a voltaic battery for electro-plating. This machine, which is in use at Mr. Fearn's electro-gilding works, Birmingham, and various other places, consists of a revolving wheel containing at its outer edge a number of short bars of soft iron, upon which are wound coils of insulated copper wires, giving to the bars the appearance of a series of reels; the wheel is surrounded by a set of powerful steel magnets, which are immovable, and fixed in a case, and have their ends, or poles, all pointing towards the wheel, so that as the wheel revolves, each of the reels of wire with its iron core, passes in succession between and very close to the poles of each magnet. As each of these coils approaches a magnet, a current of electricity is developed in one direction, and as it leaves the magnet a current is produced in the opposite direction, and similarly with the whole of the coils. All the corresponding ends of the coils are connected with the axle of the wheel, from which the positive electricity of all the spirals is collected by a metal spring which presses upon the axle and conveys the current onwards to the depositing solution; and all the opposite ends of wire are connected with an apparatus on the axle called a communicator or break, and this apparatus collects all the negative electricity of those ends and transmits it to another spring which conveys it to the plating vat. And thus, by quick rotation of the wheel, a rapid succession of electric impulses are generated, which are employed for plating purposes in the same manner as the ordinary voltaic current. The above machine is a very convenient source of electricity where a cheap motive power is at command, and where the quantity of electricity required is not very great.

The surface of silver deposited from the ordinary cyanide of silver and potassium plating solution has a frosted or snow-white appearance, which in many cases has to be burnished and made bright by mechanical means. This, with articles of highly figured design, and also with the interior of certain articles that required to be made bright, was a great disadvantage, as the process of burnishing is tedious, and with the interiors of vessels also very awkward to perform. As with the difficulty in the early period of the electro-process in obtaining thick deposits of firm silver, a little circumstance was the cause of that difficulty being overcome, so was it with this obstacle, and it happened as follows:—In the process of copying figures for electro-typing by a mixture of wax and resin, the surface of the wax is covered with a film of phosphorus by means of a solution of phosphorus in bisulphide of carbon. It was observed by Mr. Millward, at Messrs. Elkington's establishment, that when these prepared wax moulds were put into the cyanide of silver-plating solution for the purpose of receiving a coating of silver, other articles, such as spoons, forks, &c., which were being plated in the same vat, and especially those nearest to the wax-moulds, acquired a coating, more or less perfect, of *bright* silver, which occurred sometimes in patches, and sometimes extended all over the articles, instead of the ordinary snow-white deposit. This circumstance attracted attention, and induced Mr. Millward to try the effect of adding bisulphide of carbon alone to the plating liquid. Considerable success soon resulted; but at this juncture the secret escaped, and in consequence thereof a patent was taken out, March, 1847, by Mr. Millward and a person of the name of Lyons, who had acquired a knowledge of the secret, for producing bright deposited silver by means of bisulphide of carbon. This process has been constantly employed ever since, and is now in extensive use, and with its aid the silver is rendered very bright and the amount of burnishing required very considerably reduced, but it has the disadvantage of making the deposited silver much harder. Bright copper had been observed about two years before bright silver, and occurred whenever a large number of phosphorized wax moulds were put into a solution of sulphate of copper to receive an electro-deposit of copper. Other substances possess the quality of imparting brightness to deposited silver, but none in so satisfactory or eminent a degree as bisulphide of carbon: among these may be mentioned bicarbonates of the alkalies, and many organic compounds, and it is probable that the brightness depends upon a *gaseous* body being dissolved in the plating liquid.

No important improvement in the electro-deposition of silver has since been made; and the process at present in use may be briefly described as follows:—A certain quantity of pure or virgin silver in a granulated state is taken, allowing about one ounce for each gallon of plating-solution required (the actual proportions, however, in use by manufacturers vary from a quarter of an ounce to two or three ounces of silver per gallon), a warm mixture of four parts of pure and strong nitric acid and one part of water, contained in a capacious vessel of glass or stoneware, is placed in a warm situation, where the air-fumes may readily escape without injuring persons or furniture; and small quantities of the silver are added, from time to time, as fast as it dissolves, care being taken not to add it in too large quantities at a time—otherwise waste will ensue—until nearly all the silver is dissolved. It is advisable to employ a deficiency of the acid mixture in the first place, and to add more of it towards the end of the process, taking care not to add more than will dissolve all the silver, but rather to leave a little silver undissolved, even with the liquid quite hot; by this means, the presence of much free acid is avoided, and an after-loss of cyanide of potassium and escape of poisonous fumes of prussic acid prevented. Each ounce of silver requires nearly one and three-quarter ounces of strong nitric acid to dissolve it.

The solution of nitrate of silver obtained is now considerably diluted with *distilled* water in a capacious vessel of stoneware, and there is added to it, in portions at a time, with stirring, a solution of cyanide of potassium of moderate strength as long as a white precipitate or cloud, which is cyanide of silver, is produced; this precipitate is allowed to subside between each addition, and it is very particular that as the precipitate produced becomes less copious the cyanide of potassium solution should be added more sparingly and at longer intervals of time, and that on no account should that liquid be added after it fails to produce a precipitate. This point requires some care and experience, but may be known by the cyanide of potassium solution producing a *transparent* but slightly brown appearance where it passes into the white and cloudy liquid: this transparency is caused by its dissolving the suspended fine particles of cyanide of silver; if by accident too much cyanide of potassium has been added, a cautious addition of dilute nitrate of silver solution (for which purpose a little should be reserved) in a similar manner, will bring it back to the neutral or proper point: the whole is then well stirred and allowed to subside until the supernatant liquid is quite clear. Each ounce of silver dissolved requires nearly half an ounce of cyanide of potassium of ordinary quality to precipitate it.

The supernatant liquid is then filtered through a calico bag, the sediment put into the bag, and the bag filled five or six times successively with spring water. A small quantity of hydrochloric acid is added to the filtered liquid to precipitate any dissolved silver (of which there is always more or less), in the form of chloride of silver: this is allowed to subside, the clear liquid is thrown away, and the sediment retained on account of its silver.

Now, the wet contents of the filter are transferred to a capacious vessel, and to it is added, with constant stirring, a strong solution of cyanide of potassium until it is all dissolved, a memorandum of how much cyanide of potassium is used being made, because the amount varies greatly in different cases and is dependent upon the quality of that substance. If the cyanide of potassium is of ordinary quality, each ounce of silver employed will require about two or two and a half ounces of cyanide of potassium to re-dissolve it; whatever the quantity required to re-dissolve the cyanide of silver may be, an equal additional amount should now be added to the mixture to constitute *free* cyanide, and sufficient water then added to dilute the solution to the proportion of one ounce of silver per gallon, or any other strength that may be desired: the solution now only requires to be filtered and it is ready for use.*

In coating articles with silver by means of this liquid a voltaic battery is employed: the battery varies in its arrangement in different establishments and in different cases, but always contains dilute sulphuric acid and plates or bars of zinc. The battery most commonly used consists of a sheet of copper and a plate of amalgamated zinc immersed in a mixture of oil of vitriol and water contained in a large stoneware jar; the zinc plate is connected by a copper wire with the articles to be coated, and the sheet of copper is connected by another copper wire with a sheet of pure silver, which is hung in the plating-solution near the articles. In this arrangement the electricity is generated by the action of the acid and water upon the surface of the zinc, and passes from the zinc through that

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* This process is illustrated in Plate V. fig. 2. See also explanation at ion of article.

Fig. 3

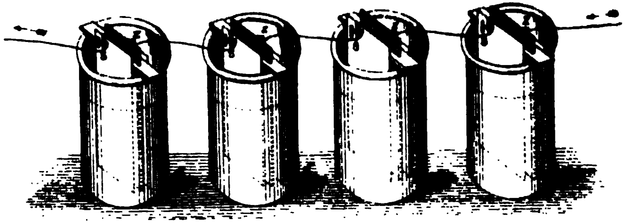


Fig. 1

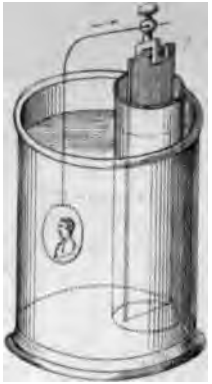
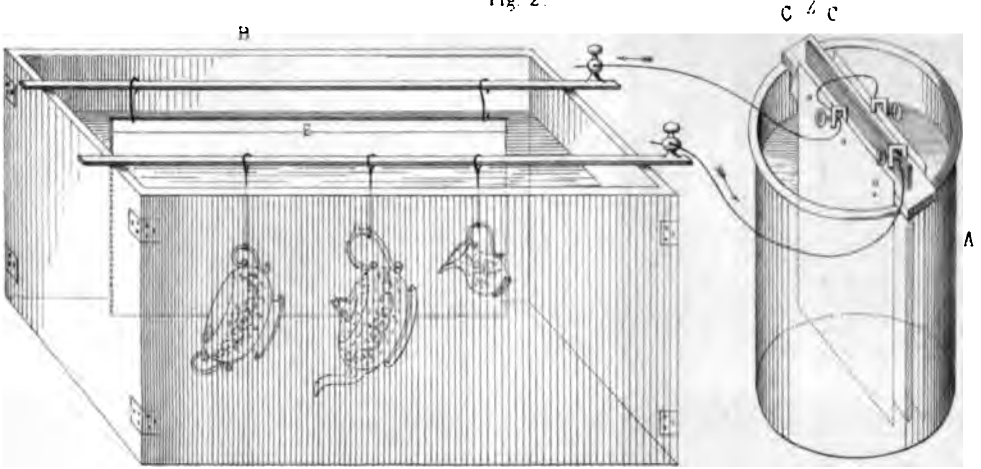


Fig. 2.



liquid to the sheet of copper, then along the copper wire to the sheet of silver, then through the plating-liquid to the articles to be coated, and back to the zinc plate by the other copper wire.

The electricity in passing from the surface of the sheet of silver into the plating-liquid causes the cyanide of potassium to act upon that metal and dissolve it, and at the same time the electricity passing into the surface of the articles decomposes the solution in contact with them and causes it to yield up its silver to those surfaces; and these two simultaneous actions are perfectly equal in amount, *i. e.*, for every ounce of silver dissolved on one side an ounce of silver is deposited on the other, and thus the amount of silver in solution remains unaltered for an indefinitely long period. The only alteration that takes place in the liquid is that it becomes unequal in composition in different parts—that portion of it about the dissolving-plate becomes richer in silver and specifically heavier, and therefore sinks to the bottom of the vat, whilst that about the articles becomes poorer in silver, specifically lighter, and rises to the surface; and this inequality renders it necessary to stir the liquid occasionally, otherwise the quality of the metal deposited upon the articles would be different at the upper ends to what it is at their lower ones.

In most electro-plating establishments two or three such battery-cells as those described are used for depositing silver, and in the early period of plating a much larger number was used. When several cells are employed, the zinc plate of the first one is connected by a wire with the copper of the next, and so on throughout the series, leaving the extreme copper at one end and the extreme zinc of the other to be connected with the vat in the manner described: by this means there is a course opened throughout for the electricity to circulate, and each additional cell or pair of plates imparts an additional impulse to the electric current.*

Several other kinds of voltaic batteries besides the one described are also extensively used in electro-deposition; there is Smee's battery, which contains a sheet of platinized silver instead of the sheet of copper; Grove's, which consists of amalgamated zinc in dilute sulphuric acid and a sheet of platinum in strong nitric acid, the two liquids being kept from mixing freely, but allowed to touch each other by means of a separating diaphragm or cell of unglazed (*i. e.* porous) earthenware; and Bunsen's battery, which is similar to Grove's; graphite (obtained from gas retorts) being, however, employed instead of the sheet of platinum. Daniell's battery, which consists of amalgamated zinc in dilute sulphuric acid, and copper in a solution of sulphate of copper, the two liquids being separated by a porous partition, is not much used for electro-plating; and the preference of one battery over another for electro-deposition depends partly upon the bias of the plater in favour of that particular battery, but chiefly upon the special purpose for which the battery is intended; in cases where great resistance is offered to the passage of the electric current, as in solutions for coating articles of iron, &c., with brass, the more powerful batteries of Grove and Bunsen are used. Whichever of these batteries is employed, and whatever may be the metal intended to be deposited, the article to receive the coating is always connected with the *zinc* plate of the battery, and the metal to be dissolved is connected with the copper, silver, carbon, or platinum, as the case may be.

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* Plate V. fig. 3. Zinc and silver are here used.

All metallic articles that are to be coated with silver or other metals by electro-process require to be perfectly cleaned and prepared before being placed in the plating-liquid, otherwise the metal deposited upon them will not adhere properly. To clean them they are at first immersed in a boiling solution of caustic potash to remove greasy and tarry matters; then, if they are formed of German silver, brass, or copper, they are washed in water, dipped momentarily into aquafortis, again washed in water, then dipped into a very dilute solution either of nitrate of mercury or of cyanide of mercury and potassium, and immersed in the silver-plating vat. In cases where it is desired to know the quantity of silver deposited upon them, they are weighed after cleansing, and also at intervals during the process of deposition. Articles formed of Britannia metal, lead, tin, and similar metals or alloys, are not dipped into aquafortis, but immersed in a weak silver solution immediately from the caustic potash liquid, to receive a thin preparatory electro-coating, and then transferred to the ordinary silver vat. The thickness of silver deposited upon articles is frequently very minute, as may be judged from the fact that full-sized iron snuffers are sometimes wholly coated with silver for two-pence each pair, and other common articles at proportionate prices.

After receiving the coating of silver, much remains to be done to the articles before they assume a saleable condition, they have to be "scratched" by a bundle of revolving fine brass wires to remove asperities; burnished to make them bright; in some cases, they have to be "oxidized" in particular parts. This consists in wetting those parts with a solution of bichloride of platinum, which blackens those portions; and, in other cases, different parts, as, for instance, the interior of cream-jugs, sugar-basins, &c., have to be electro-gilded. And in cases where portions of the exterior have to be gilded, the remaining surface is coated with copal-varnish, to prevent the gilding from taking place on those parts. And, finally, the articles are washed in clean water, and at once immersed in hot, dry saw-dust, which absorbs the moisture and dries them quickly, before they have time to tarnish. The processes of preparing and finishing articles are, in nearly all cases, much more troublesome than that of plating itself.

These various points of information are only the *outlines* of the process of electro-plating, and for the details the reader is referred to the various published works on the subject.

The scientific perfection of electro-deposition consists in its definite mathematical character. Under carefully prepared conditions, all the chemical actions that occur in the battery and plating-vat stand in certain precise mathematical relations to each other; for every 32½ parts of zinc dissolved in each cell of the battery, there are 108 parts of silver dissolved and 108 parts deposited in the vat; or if it be a copper solution, 31¾ parts of copper, or an antimony solution, 40 parts of antimony; for every 32½ parts of zinc dissolved in the battery, there are 9 parts of water decomposed, and if it be a Smee's, or a common zinc and copper cell, there is 1 part of hydrogen set free at the negative silver or copper plate; and similarly with all the chemical actions taking place in the various battery-cells and depositing liquids. Each action in a given circuit stands in a certain mathematical relation to each and all the others, and this is known as the law of "definite electro-chemical action."

The artistic advantage of electro-deposition consists in the great facilities it affords for the exercise of taste and design, and for more accurately imitating the forms of nature, as in rocks, animals, fruits, trees, &c. And its domestic utility and household economy consist in the greater degree of cleanliness and beauty obtained at so moderate a cost.

As long as arts and manufactures are left to be directed and improved by simple experience, their progress is extremely slow; but directly scientific knowledge is successfully applied to them, they advance with astonishing speed. For years the manufacture of plated metal wares existed without making any material progress; but, on the application of science, its progress became surprising, and called the attention of all persons to the new process.

Thirty years ago electro-plating for commercial purposes was unknown; but as soon as Jacobi and Spencer made known the results of their electrical experiments upon metallic solutions, the manufacture of plated wares began to advance; and so rapid has been its progress, that, at the present time, thousands of persons are employed in it, and electro-plate productions are used in all parts of the world.

Thus it is that man, to some extent the servant, but hoping to become more the master of nature, is daily striving to acquire a greater knowledge of the workings of natural forces, and to apply those forces to human benefit; he first becomes the obedient disciple of nature, in order that he may ultimately become its director; and so great a degree of success has already resulted from this course, that we are justified in expecting that, at some future time, science will extend its helping hand to all trades and manufactures, and that ultimately scientific principles will be universally recognized as the great "regulators of productive industry."

EXPLANATION OF PLATE V.

Fig. 1 represents what is termed a "single-cell electrotype apparatus." It consists of an outer vessel of glass or stoneware nearly filled with the depositing solution of silver or copper, as the case may be; standing within it is a narrow, deep vessel of *unglazed* or porous earthenware, containing a plate of amalgamated zinc, and about three-fourths filled with dilute sulphuric acid. The article to be coated is connected by a clean copper wire and brass screw with the zinc plate, as shown in the engraving, and is immersed in the metallic solution.

Fig. 2 represents the actual apparatus for electro-plating, as at present employed. It consists of two parts, the battery A, and depositing trough or vat B; Z is the zinc plate, and C C the two copper plates of the battery, and S is the silver-dissolving plate in the metallic solution: the arrows represent the direction of the electric current.

Fig. 3 represents the mode of connecting several battery-cells in series when additional electric power is required: the battery-plates in this sketch are represented as being composed of zinc, Z, and silver, S, instead of zinc and copper; the zinc of the first cell being connected by a copper wire with the silver of the second; the zinc of the second with the silver of the third; and so on.

NOTES OF THE EXHIBITION.

No. II.

THE MINERALOGICAL DEPARTMENT.

BY PROFESSOR D. T. ANSTED, M.A., F.R.S.

A COLLECTION of Minerals, carefully made, well arranged and selected, and placed with a view to their economic value, would, perhaps, be as interesting and attractive as any of those collections occupying the numerous halls and almost interminable corridors at South Kensington whose glittering treasures are soon about to fade and melt away from before us. Objects of large dimensions, of wonderful beauty of form and colour, of vast cost, and of enormous intrinsic value—objects representing great sources of national wealth—objects noble in their massive proportions, and interesting in proportion to the difficulty experienced in obtaining and removing them—collections speaking for themselves as showing series of manufactures and processes; all these certainly admit of being placed in such a way as to astonish, amuse, and instruct.

That such might be the result of a great series, illustrating the mineral wealth of the world, seems beyond a doubt; but that any such result has been attained at our great International Exhibition no one will venture to assert. There is ample material, whose effect is lost for want of right associations. There are separate objects in abundance, capable of attracting and really attracting crowds; there is gold exhibited in a profusion and barbaric splendour worthy of the earliest period of human history. Never, perhaps, in the world's history was such raw material of representative wealth brought together and exposed to public view. There are copper ores also—slices of veins adapted to make the mouths of mine speculators water. There are building stones and marbles, coals and china clay, and manufactured results in abundance. At a distance from these are plans, models, and illustrations of the mode of rendering them useful. But few ideas can be obtained by the uninitiated. There is no sequence. All is disorder and confusion; little assisted by any of the published descriptions—not at all assisted by arrangement within the building.

After a general review of all the objects in the Exhibition belonging strictly to the department of mines and quarries, minerals, metals, and mineral manufactures; and after carefully considering what is meant by progress in such subjects and what is deserving of reward in such a department, we think it may be both useful and interesting to the readers of the "POPULAR SCIENCE REVIEW" to know the conclusions arrived at by an independent observer somewhat accustomed to examine and compare such matters. Whatever opinions may be expressed, the facts on which they are founded will, at any rate, be stated, and the student who has also examined the collections, may compare his impressions with the opinions here given, while those who have not been so fortunate as to see for themselves will be better off by reading this connected outline than by any study of the disjointed catalogues.

The great value, if not the only use, of collections such as have been placed in the International Exhibition must be to show, for the purposes of comparison, the sources of material wealth provided by Nature in various countries or districts. And this wealth must be shown, in order that, where it exists and has been hitherto neglected, it may be made available; and where, in two districts, it has been treated differently, the methods may be compared, and the best adopted for the future. It is desirable also that where new contrivances have been introduced, they should be made known to those concerned; and, generally, that the peculiar conditions of minerals and the varieties of wealth of different districts should be prominently presented for investigation. When, in the course of years, new discoveries of material or new applications of old material have been made, these, of course, mark progress. When new contrivances of working or manipulation have been invented, these should be clearly reported; and they also mark progress. When, as in raw material, there is no novelty, and the case hardly admits of anything of the kind, the raw material from different districts may still be so placed as to allow of better comparison. When a raw material is important, not for itself but for some manufactured material of which it is the foundation, then should the raw and manufactured materials be placed side by side.

Bearing in mind these principles, let us conduct the reader to the Exhibition, not confining ourselves to Class I., but extending our investigation to those other departments that include the same kind of objects; of these Class X. *a*, may be considered the most important.

The objects group themselves naturally enough under several heads, viz.:—Mineral Surveying, Mining Operations, Mineral Products, and Manufactured Minerals. Let us endeavour to follow each through the Exhibition, both of English and foreign articles. The task is not, perhaps, easy, but, for any useful purpose, we believe it is the only one.

1. *Mineral Surveying and Mining Operations.*—The long array of geological maps, commencing with those of the British islands, and including most of the countries in which mining operations of any kind are carried on, is one of the most important marks of progress in the Exhibition. In no department is the progress of scientific research more clearly indicated, and in none is it so manifest that the march of improvement in mining is no longer checked by those who adhere to the old Cornish maxim: "Where it is, there it is." Could one feel satisfied that the vast amount of work indicated on the geological maps exhibited is all sound and conscientious, the advance would, indeed, be little short of miraculous to those who remember the exhibition of such maps and accompanying sections in 1851. Unfortunately, these maps are, many of them, only first approximations; and it will require more labour to correct and set them right than has been taken to construct them. In this matter, however, it is certainly true that positive error is the first step on the road to truth. Where there is nothing to find fault with, no advance is made; but it is easy for any one using an imperfect map to correct it.

Among the foreign maps, the Austrian are the most extensive and showy, and some of the Prussian probably the best. The increase in the coloured portion of the maps of the Ordnance Survey of the British Islands since 1851 is not large in appearance, but the advance is real, and for the most part trustworthy.

The mining plans exhibited, and the various models of mining operations, do not offer anything remarkable either in novelty of method or illustration. Certainly, they offer no proof of progress; and in this respect there has probably been little done within the last eleven years that had not been as well done previously. It is but a very short time since one of the most distressing accidents on record occurred in a coal mine, from a neglect of the very first principles of economic mining—that of having more than one access kept up to every part of a mine except the newest and most advanced headings. There is nothing in any of the plans exhibited that shows any practical advance on the old methods of winning coal or getting ores.

Although, however, there is not much new matter, there are some admirable photographs of mining and quarrying operations, especially the latter—so good as to deserve the most careful attention. Perhaps the photographs are the most instructive, as they are certainly the most pleasing and most easily understood of all the mining and quarrying illustrations.

Of mining models there are several, very well constructed, and one that ought to have been exceedingly popular. A large gold crushing and washing machine, in the great court of the Eastern Annexe, was long unable to do itself justice, and the interest that would have attached to it was thrown away on a hand illustration with a tin basin. Important as the subject of gold-mining is, there are few noteworthy modifications of ore-dressing especially adapted to gold sands, if we except some very weak repetitions of old German machinery introduced as novelties. An ingenious model of the method used in some of the Hungarian mines is exhibited. There are some ingenious contrivances to prevent accident on the breaking of the chain or lifting-gear in shafts.

2. *Mineral Products.*—It may well be supposed that the great strength of the exhibition of minerals would lie in this direction, and it certainly does so. Very irregularly exemplified —some departments sadly weak, some ridiculously prominent—some difficult to see, and more difficult to judge of; still there is within the walls of the building an amount of material which, if it had been fairly presented, would have possessed the most absorbing interest.

Let the reader figure to himself the result had there been in the Exhibition a Court of the Precious Metals. Had all the gold exhibits been collected into one space, the mere area occupied would have helped to impress the visitor. The gilt pyramid, ridiculous in the place which it filled, would have assumed an importance and a meaning in the centre of such a court; and the various collections grouped around would have told with wonderful effect their important tale. The whole history of gold, its real properties, and its sources of value as a representative metal, would have been at once felt and understood. Never was there a better opportunity, and never was an opportunity so lost and frittered away.

In spite, however, of everything, the collections of gold, especially from Victoria, are of the most singular interest. The grains and the pepites, the small and the large nuggets, the crystals and the flat discs—all are present in abundance and variety—all are good and true. The largest nuggets are well represented in useful models, so as to give completeness to the exhibit. Besides the Victorian gold, there is much from other parts of Australia. California is not represented, but Vancouver's Island has sent an interesting series. A remarkable and interesting group of specimens is sent from the recently discovered localities in North Wales, and there are some specimens, not without interest, from the Brazils.

Near the gold is placed the metal platinum, in lumps of a magnitude never before produced, surrounded with the still rarer metals—iridium, osmium, rhodium, palladium, and ruthenium.. In this case, the manufactured platinum is exhibited by Messrs. Johnson and Mathey, side by side with the metal. The French manufacturers of the same metal have placed some fine chemical utensils in their court since the opening of the Exhibition. These were, no doubt, intended to outshine the productions of Messrs. Johnson and Mathey. They are extremely beautiful, but inferior in variety, and not superior in execution.

As an exhibition of progress, then, the precious metals, with the exception of silver (which, although there are some fine snags from Norway, is little exemplified either in ore or metal), must be considered as justifying every expectation. All that is remarkable is new, and has never been put together as a group before. All that was wanted was that the articles should have been so placed as to illustrate each other.

Another interesting group might have been made by bringing together a number of miscellaneous and mixed metals and metalliferous minerals. A beautiful series of manufactures of aluminium—a metal that will some day enter largely into use—was itself a great illustration of progress, though a final result is not yet attained. The manufactures of German silver are well illustrated, but the illustrations as usual are quite unavailable for comparison. Ores of mercury are shown from various localities. Ores of chrome, antimony ores, and other miscellaneous but valuable minerals, may be found huddled into corners unnamed and neglected amongst the multitude of more showy, but less really interesting objects around.

Copper is one of the most important and valuable of the common metals. Some of its ores exhibited are very remarkable, but are accompanied with no general account, and can hardly be said to be instructive. From Australia, the series is extremely large, and includes many specimens of great interest. From Canada, also, there is a fine series. Native copper—the rich carbonates, both green and blue, and the more common sulphurets, are all present. Had they been placed so as to be capable of direct comparison with those from other ore-producing districts, and had the various important details of the veins been duly recorded, this part of the Exhibition might have possessed considerable value. As it is, few, probably, will look twice at the long series of dust-covered minerals dotted at intervals over all parts of the building—on tables in and near the Eastern Annexe, on the floor in Greece and Sweden, piled in a corner in France and Belgium, and only arranged in the Zollverein and Austria. Spain and South Africa, the Brazils and Portugal, and many other countries, exhibit specimens for the most part utterly unrecognizable.

To lead and zinc ores, the remarks already made with regard to copper apply in a general way. The varieties exhibited are, however, fewer and less important. There is nothing remarkable suggested as to either the ores, or the treatment of the ores, of any of these metals, or of tin.

Iron comes next in order. There is in the Exhibition no general collection of ores, and, on the whole, the modern sources of supply in England and Europe are somewhat imperfectly indicated. Still, with some search, and by wandering to some distance, a valuable series may be made out. The metal itself is largely and well exhibited. Progress might easily have been shown in this matter by a reference to the vast additions to the resources of ore, since 1851. Progress is shown in the increased magnitude of the smelting furnaces. Models of furnaces are exhibited the yield of which is said to reach, in the case of Messrs. Schneiders' works, more than a hundred and twenty tons in the twenty-four hours. For these large yields the rich hæmatites are employed. Considering the valuable series of iron ores in the Exhibition of 1851, it is much to be regretted that the Museum of Economic Geology did not take the opportunity to complete the series by a systematic arrangement of ores from the new sources.

England, of course, is not alone in the exhibition of iron; Belgium, Austria, Prussia, Sweden, and many other countries have exhibited all the varieties, and generally in a very favourable state. There is much advance observable in the manufacture of the metal, and in the magnitude of the pieces that can be cast, forged, and turned.

But the metals form only a part of the vast series of mineral products. If the precious metals deserve a court, and would have justified great exertion to bring together the various specimens for comparison, the most precious of all minerals, *carbon*, would have well filled another and a prominent place. Certainly, in the exhibition of minerals, carbon should have been placed first, if money value is regarded; and if variety of condition is interesting, no substance in nature can compare with it. As it is, there are scarcely two important exhibits of coal near each other.

Leaving the diamond to take its place among manufactured jewels for personal decoration, there yet remain coal and graphite among carbon minerals. The former is exhibited very imperfectly; the latter very perfectly, thanks to the recent discovery of M. Alibert. Of coal there are no very fine specimens, such as graced the Exhibition of 1851, the only representative of them being an ugly pile of square blocks of poor mineral from Nova Scotia, badly put together, and utterly unillustrative, rather resembling a large walking-stick than a coal seam, but—by the geologists on the jury—rewarded with a medal as "one of the thickest known seams in the world." As there are known seams of forty, sixty, and even a hundred and fifty feet in thickness, this medal at least seems undeserved.

The coals, like the ores, are distributed over the whole building, and, for the most part, soon became in such a state that no judgment could be formed as to their merits. Of the whole number, the Austrian are perhaps the most complete, but they are badly placed, at the bottoms of wooden boxes, and almost out of sight. The Zollverein specimens are well arranged, well selected, and instructive; the Belgian are large, and also well selected; but from other countries the varieties are rarely sufficiently marked to justify an opinion. One thing, however, is very clear and very satisfactory. Almost every country in Europe, and many countries elsewhere, possess coal, and are aware of the fact. There is more progress in this matter than might, at first, be supposed, and the progress is steady. It might have been made very clear. There are some fair examples of coke.

While coal has long been steadily advancing in use, and is constantly better known and more worked, another form of carbon—graphite, or plumbago—has very long remained stationary. For many years there has been actually no yield whatever of the best kinds of this mineral in the old locality, and no new deposit has been heard of. Suddenly the Exhibition brings us acquainted with M. Alibert, a Frenchman, who has found, far away in the wildest parts of Siberia, a mass of graphite so large and important that its discoverer makes royal presents of it in the most liberal manner, and seems ready to supply the European market into the bargain. Russia, on this occasion, has again astonished the world. In 1851, the enormous and costly display of veneered malachite made it impossible for other exhibitors of that beautiful stone to be attended to. In 1862, the plumbago trophy carries off the palm, and is equally unapproachable.

To those who have not seen this curious exhibition it is almost impossible to give an idea of the effect. Cut and broken into every shape; rough and polished, and of many sizes—surely so much black lead was never prepared for view before, and, probably, never will be again. It is said to be equal in quality to the best from Borrodale, and is already largely manufactured into pencils by the celebrated German manufacturer,

M. Faber. The value of the black lead exhibited must very much exceed a thousand pounds sterling.

With some of M. Alibert's plumbago, and also serving as the footing for a group of stuffed animals, are exhibited the largest specimens ever seen of that singularly hard and rare mineral, nephrite, or jade. The principal stone weighs upwards of half a ton. As well might we expect to see a diamond weighing a pound as a precious stone of this magnitude; but there it is before us in the nave of the building, not staring one in the face, but modestly retiring, and probably not noticed by one out of ten thousand persons who think they have seen all the remarkable things, and who actually have looked at the stuffed animals that partly conceal this treasure. As it lies in the case uncut, the value is estimated at about £1,600 sterling. Other wonderful specimens of polished *pietra dura* are adjacent, cut into vases and columns, little remarkable for their form, but of the most extreme hardness. These articles are among the most characteristic of the Russian and Swedish manufactures in stone.

3. *Manufactured Minerals.*—Of other stones, valuable for their great beauty, and worked into decorative shapes, there are many specimens. The rich dark green and red serpentines of the Lizard, in Cornwall, are the most striking and numerous articles of this kind exhibited. Some are very good, but in many of them an absence of good taste must be remarked, for an attempt has been made to use them for purposes for which they are not adapted. Very beautiful in places, these stones abound in flaws and weak white parts. Thus a large flat surface is generally a failure, while smaller and worked surfaces conceal or avoid the flaw.* Except the black marble of Derbyshire, there is no more beautiful or costly marble in the British islands, and few finer in Europe, than this serpentine; and, although there are many objects constructed of it in bad taste, there is a decided improvement in taste and style of manufacture when comparison is made with 1851.

With much that is beautiful in marble manufacture, there is much that is weak, and much that is positively bad, nor is the bad taste confined to our own countrymen. In all these matters progress is desirable, and nothing can promote it more than the means of comparison afforded by a grand exhibition open to the whole world. With the good taste in style generally observable in Italian works of art, there is an adaptation of material to its object which cannot be too carefully studied. Thus the forms adapted for marble fail in granite. The granite manufactures, chiefly from Aberdeen and Cornwall, are beautiful in quality, but small in number and variety.

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* This variety of serpentine requires to be treated almost like agates for cameos. The places and colours of the flaws should be studied and converted into beauties.

Of constructive materials, slates are the most remarkable. The exhibition of them in 1862 is far superior to that in 1851. Probably no such collection as that now made was ever brought together, and certainly none could be obtained out of England. These objects are not perhaps attractive; but they astonish by their size, and by the perfection of the cleavage, admitting the preparation of long, hard, firm slates, a sixteenth of an inch only in thickness, and of slabs, without a single flaw, two hundred square feet in area. The continental slates are very poor compared with these.

One word here with regard to the imitative marbles, enamelled on slate, by Mr. Magnus. It is impossible to praise too highly the progress made by this manufacturer since 1851. He has attained so near to perfection, that it is difficult to imagine what will be his next improvement. These imitations seem especially adapted for house decoration, owing to their extreme hardness and moderate cost.

We have little space left to notice the remaining objects exhibited in this large and important class. China and pottery clays, fire-clays, and sands, do not change, and show no progress. Mica and steatite, and some other minerals exhibited, are equally stationary. There are a few educational collections in the building, but these also offer little worthy of notice; and the same remark may be made concerning the cements and artificial stones.

One word of comparative remark in regard to the different countries. Except Australia, no country has shown a great stride in advance of the last Exhibition in its mineral produce. England, Wales, and Scotland, have sent less, and what is sent is on the whole of smaller interest, than before. Ireland has hardly sent anything. France has done little, and not better than before. Belgium has done well, and the Zollverein admirably. Austria, on the whole, is good, but justice has hardly been done to its collections. Canada, and the other British provinces of North America, are respectable, and even good. Spain is slovenly, and Portugal little better. Russia decidedly good. Sweden, Norway, and Denmark, not remarkable. Brazil is good.

Thus, in a few words, we have endeavoured to sum up the impression made by a study of the minerals of the Great Exhibition of 1862. We doubt exceedingly whether another such exhibition, conducted in the same manner, would be in any sense desirable at the end of another decennial period; for the means of instituting a comparison are so very few, and the effort to compare so fatiguing, that probably very few persons have made the attempt. That the juries themselves did not examine too closely seems likely, from the profusion of medals, and "honourable mentions," distributed without much judgment, and often entirely without or against reason.

While, however, we believe, that in the state presented to the public, the Exhibition in this department is not what it ought to have been, we are satisfied that an orderly grouping of similar objects from different countries, for the purposes of comparison, would be productive of great good. It is not easy to say how far this is practicable generally. It may not be desirable in manufactures, which of themselves are definite objects of interest. But in the case of raw material, there seems little reason to doubt that order might be attained, and no doubt whatever that it is in every sense desirable and absolutely essential to ensure a proper use being made of the opportunity offered.

No. III.

CHEMICAL PRODUCTS.—THE APPLICATION OF WASTE.

BY WILLIAM CROOKES, F.C.S., EDITOR OF THE "CHEMICAL NEWS."

THE progress of our great chemical manufactures during the last ten years, as exemplified in the International Exhibition of 1862, appears chiefly to have been directed towards the utilisation of waste substances. The casual visitor to the Exhibition, wandering through the Eastern Annexe, and noticing the grand scale and great importance of some of the manufactures there illustrated; the gorgeous colouring matters exhibited by Messrs. Perkin and Son; and Simpson, Maule, and Nicholson; the stupendous blocks of alum; the beautiful yellow and red crystalline masses of ferro- and ferri-cyanide of potassium; the enormous cakes of paraffin, a chemical curiosity in 1851, one of the largest chemical manufactures in the world in 1862; and, knowing the incalculable boons which science has bestowed upon our national wealth and the world's civilisation by the introduction of the lucifer match, and development of the phosphorus manufacture, artificial manure, paper, &c.,—the visitor would be little prepared to hear that most, if not all, these important commercial products are manufactured from materials formerly thrown away, and at first sight apparently valueless and repulsive.

Dirt has been aptly defined as being valuable matter in the wrong place, and it is a striking characteristic of the chemistry of the present day that it converts substances, apparently the most worthless, into commercial utilities, and even fashionable luxuries. The manufactures alluded to above, and those of Prussian blue, disinfectants, glue, &c., are striking illustrations of this chemical utilization of waste materials, and we shall endeavour, in the following remarks, to show how they have all sprung into existence by the application of chemical facts and principles to such waste materials as gas-water, coal-tar, rags, and bones.

When coal is distilled in close vessels for the purposes of the gas manufacturer, various other products are obtained at the same time. A large quantity of offensively-smelling water comes over; the various sulphur compounds present in the coal yield up this element to the gaseous products, whilst a considerable bulk of tarry matter is also produced. Now the object of the manufacturer being to produce as much gas as possible in a practically pure state, all these accessory products were for many years looked upon as necessary evils, to be got rid of as quickly as possible. The gas-water and tar were thrown away into the nearest stream, where they killed the fish and poisoned the atmosphere for miles around, whilst the sulphur was removed, or at least supposed to be removed from the gas by means of lime, or, as more recently adopted, through a mixture of sawdust and oxide of iron, about which more will be said anon.

The first of these noxious products, the gas-water, has been utilized in the following manner. It owes its bad smell principally to the presence of ammonia and sulphur compounds, and it is only necessary to add some quicklime to this, for it to seize upon the acids with which the ammonia is in combination and liberate the alkali. This gas is conducted into chambers where it meets with carbonic acid, forming, after appropriate purification, the salt known in commerce as carbonate of ammonia, about 2,000 tons of which are made annually from this liquid. If, instead of distilling the gas-liquor with lime, a strong acid is added to it, hydrochloric for instance, itself a waste product, the compound known as sal-ammoniac is produced, which is of very great value in the arts, being the principal source of the more common salts of ammonia met with in commerce; the *liquor ammoniæ* of pharmacy, or hartshorn, being made by distilling this purified sal-ammoniac with lime, and conducting the evolved gas into water. The uses of this ammonia are well known; not only is it largely employed in medicine, but, when mixed with some aromatic substance, it is used in scent-bottles; thus affording a striking instance of the transmutations effected by scientific agency, the fœtid liquid of the gas-works being transformed into a scent used by ladies as a cherished luxury. Besides sal-ammoniac, the manufacture of which from gas-water exceeds 4,000 tons annually, about 5,000 tons of sulphate of ammonia are also produced by adding sulphuric acid to the gas liquor. This is of great value as a manure, and is also one of the principal component parts of alum, so largely used in dyeing and calico printing.

This compound alum consists of the earth alumina in combination with ammonia and sulphuric acid. Chemically speaking it is a double salt of sulphate of alumina and sulphate of ammonia, and is prepared among other ways by acting upon a mineral containing alumina with sulphuric acid, and then mixing the resulting liquid with sulphate of ammonia. For the purposes to which alum is applied the sulphate of ammonia is superfluous, as all that the dyer wants is a solution containing the earth alumina; but it must have no impurities in it. Now the only practicable way of purifying a salt is by crystallization, and it so happens that alumina salts are about the most uncrystallizable in the whole range of chemistry. Fortunately, however, the double salts which alumina forms with alkalies possess, like most double salts, very strong crystalline tendencies, and therefore manufacturers add sulphate of ammonia to the sulphate of alumina in order to obtain a compound which is capable of ready purification owing to its eminently crystallizable properties.

But the alum manufacturer is not only indebted to gas makers' by-products for his ammonia, but likewise for the sulphuric acid. We mentioned that one of the chief impurities in gas was sulphur, and alluded to a method of removing this body by a mixture of sawdust and iron. The action of the sulphur compound upon this is to produce water and sulphide of iron; when it has in this manner absorbed as much sulphur as it can, air is passed through the mixture; the effect of this is to convert the sulphide of iron back again into oxide of iron, the sulphur being separated in the form of powder. The mixture being in this way revivified is ready to absorb a fresh quantity of sulphur-impurity from the gas, and thus the processes go on alternately until the pores of the mixture are completely choked up with the deposited sulphur.

This spent material is now used for the manufacture of sulphuric acid by burning it in properly constructed furnaces, and allowing the products of combustion to mix with nitrous vapours and [illegible] enormous leaden chambers. The sulphur is caused to combine with the greatest possible amount of oxygen, becoming converted into sulphuric acid, or oil of vitriol as it is generally termed when in a concentrated form. Sulphuric acid, which is also made from other sources of sulphur, is one of the most important chemical manufactures of the country, and upon it depends the equally important manufacture of soda from sea salt. An eminent philosopher* of our times has expressed the opinion that the commercial prosperity of a country may be estimated by the amount of sulphuric acid which it produces, and that the consumption of soda affords a fair criterion of a nation's civilization, inasmuch as soap and glass, the manufacture of which depends upon these former, are inseparably connected with our ideas of cleanliness and comfort. Respecting the *soap-test*, there may be some reasons to question its accuracy, but the production of sulphuric acid lies at the root of nearly every industrial art or manufacture in which chemical agencies are employed, and may thus be looked upon as a fair test of the intellectual activity of a nation.

We now pass on to the oily matter which is obtained in the distillation of coal. This is a very complex body, containing a large number of substances of different degrees of volatility, and varying greatly in their characteristics. Some are alkaline, as, for example, the now well known substance aniline, others are acid, but by far the greater portion are neutral. By appropriate chemical and mechanical means these components of the crude coal tar are each obtained in a state of purity. The lighter portions, known by the name of coal naphtha, consist in great measure of benzol, a liquid which has been for several years past applied to a considerable number of uses in the arts. For the present we will confine ourselves to the part which it plays in the production of the brilliant colouring matters, the manufacture of which is so well illustrated in the Eastern Annexe of the International Exhibition. When benzol is acted upon with strong nitric acid it becomes converted into a heavy oily liquid, of a yellowish colour, which has an intensely sweet taste, and an odour powerfully recalling that of oil of bitter almonds. This is called nitro-benzol. It is employed to some extent in perfumery and in scenting soap, as well as in confectionary, where, owing to its non-poisonous properties, it forms a good substitute for the highly poisonous oil of bitter almonds. But the chief interest which attaches to this substance is on account of the transformation which it undergoes under the influence of certain chemical reducing agents. To follow these different changes step by step would require us to devote some little space to chemical explanations and formulæ, but a general idea of the transformations may be given without taking up much space. Benzol consists of the elements carbon and hydrogen in the proportion of twelve of the former to six of the latter. The action of the nitric acid upon this is to remove one of the hydrogen atoms and put in its place an atom of peroxide of nitrogen. When this nitro-benzol is acted upon by certain chemical agents of the class called reducing (as for instance a mixture of iron-filings and acetic acid which is now generally used), the whole of the oxygen which the peroxide of nitrogen has brought into the nitro-benzol is removed, and two parts of hydrogen are added, so that the original benzol becomes transformed into a body containing twelve parts of carbon, seven parts of hydrogen, and one part of nitrogen. This is aniline, a substance which illustrates in a striking manner the effect that demand exerts upon supply. Some years ago all the laboratories in Europe did not contain a pound weight of it, whereas it is now manufactured by thousands of gallons at a time. There is still another stage to be passed before we get to the colouring matter, but here the change is by no means well understood, and the best processes are kept scrupulously secret. The action is, however, the reverse of the one just now described, being the addition instead of subtraction of oxygen, and it is by the employment of different oxidising agents that we get mauve, magenta, roseine, azuline, bleu de Paris, and other gorgeous dyes which have received arbitrary names. Mauve or aniline purple was first discovered by Mr. Perkin, and in his case at the Exhibition may be seen a very complete and beautiful collection showing the different stages of the manufacture, from the crude coal oil up to a gigantic block of the pure dye itself upwards of a cubic foot in bulk, and for the production of which the distilled products from 2,000 tons of coal were consumed. The tinctorial properties of this dye are very strong. Mr. Perkin illustrates this by exhibiting a gallon jar filled with a beautiful violet solution, the colour of which is communicated to the water by one grain only of the dye. To render this illustration more striking there is placed near it a similar sized jar filled with crude coal-tar, the whole of which would have to be employed to produce this single grain of colouring matter.

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* Baron Liebig: *Familiar Letters on Chemistry.*

The gigantic scale upon which the manufacture of these colouring matters is carried on and the perfection to which it is brought are strikingly illustrated by Messrs. Simpson, Maule, and Nicholson. This firm have succeeded in producing the beautiful colour known as magenta in a crystalline form, and one of the most striking objects in the whole department is the magnificent crown of acetate of rosaniline (the chemical name for magenta), which occupies so prominent a position in their case. One of the most curious points about this is the colour which it exhibits. The rich, deep, rose tint which the body communicates to silk, &c., instead of being concentrated and intensified until deepened almost to a black, here shines and glistens from the facets of the beautiful crystals with a rich metallic green lustre, sparkling in the sunshine like the plumage of tropical birds, or the wing cases of certain beetles. Crystals such as these are unattainable except when working on a manufacturing scale. Laboratory experimentalists had already ascertained the fact that magenta was capable of assuming a regular form; but crystals such as compose this crown—the planes in some being nearly an inch across—can only be developed by manufacturers whose crystallizing vats hold upwards of £2,000 worth of colouring matter.

Before leaving this subject, we may draw attention to the important branch of national industry which this manufacture is assuming, and pay our tribute of admiration to the skill and intelligence of the chemist who has succeeded in converting the most nauseous and repulsive by-products of gas manufacture into such lovely colouring agents. Through his exertions, England will cease to import colouring matters, and will become a dye-exporting country.

Another product of the distillation of coal now claims our attention. In 1841, Liebig said that it would certainly be one of the greatest discoveries of the age if any one should succeed in condensing coal-gas into a white, dry, odourless substance, portable, and capable of being placed upon a candlestick or burned in a lamp. Ten years afterwards, Mr. Young showed, in the Great Exhibition of 1851, a single candle made from paraffin, a waxy-looking solid, which was known to be obtained in small quantities from the distillation of peat, wood, or coal. Liebig's prediction was here fulfilled. Paraffin is absolutely identical in composition with the most luminiferous portion of coal-gas, and only differs from it in being in a more condensed state; its per-centage composition of carbon and hydrogen is, in fact, identical with that of olefiant gas. Another ten years, and the commercial manufacture of paraffin has assumed gigantic proportions, and Mr. Young's establishment for its production, at Bathgate, ranks among the largest chemical works in the world. The composition of paraffin, indeed, renders it pre-eminently adapted for the production of light. It is a beautiful wax, melting at about 130°, and when heated to a considerably higher temperature (as when burning in the wick of a candle) it decomposes into true olefiant gas, producing a beautiful white light. A paraffin candle amounts, therefore, to a perfectly-constructed and portable gas works; its flame is not like that of an ordinary candle, but is identical with that of the most perfect coal-gas, which is, indeed, self-produced as it is wanted, without any costly or complicated apparatus, and in a state of purity unattainable by ordinary means.

Intermediate between olefiant gas and the solid paraffin in condensation, but of the same per-centage composition, are a variety of other bodies which assume the form of oils more or less volatile in proportion to the number of atoms which are compressed into the same bulk. They are known by the name of paraffin oils, and their inflammability, volatility, and consequent danger, when used as household illuminants, increase as they approach in rarity the gaseous extremity of the scale, and diminish as they draw near the density of the solid. True paraffin oils must be carefully distinguished from spurious bodies of the same name;* these contain various volatile bodies, the vapours of which take fire at the ordinary temperature, and which are as dangerous as common turpentine or benzol on the approach of a light. True paraffin oil will only burn in the presence of a wick, and is, therefore, perfectly safe. When burning, it also splits up into olefiant gas, and, therefore, produces a brilliantly-white light.

We stated at the commencement of this article that some of the products of the distillation of coal were acid bodies. The most important of these is carbolic acid, which is one of the principal constituents of creosote. This has recently been employed for sanitary purposes. Its antiseptic properties are remarkable, and when united with lime, it forms one of the most powerful disinfectants known. Carbolic acid is now prepared in enormous quantities from coal-tar, and has been applied with eminent success in several towns to the disinfection of sewage. It acts, not by destroying putrefactive principles as chlorine does, but it completely arrests decomposition. Animal matter washed over with a solution of this acid may be exposed for any length of time to the atmosphere without putrefying; and Dr. Lyon Playfair mentions an instance in which a human body was preserved for two months in this way until it reached a distant grave.

When carbolic acid is acted upon by nitric acid a somewhat similar effect is produced as with benzol under these circumstances; part of the hydrogen is replaced by peroxide of nitrogen, and a body known as carbazotic acid is produced. Within the last few years this body has been extensively employed as a dye. The colour which it communicates to silk or wool is of a rich straw yellow. It is applied to fabrics with great readiness, requiring no mordant, and is one of the most permanent colours known. Carbazotic acid has other valuable properties; for instance, it is a valuable medicinal agent, being similar in its action to quinine, only when administered it exerts its tinctorial properties at the expense of the patient's skin, dyeing him a lively yellow. It also has an intensely bitter taste, and for these reasons it has been suggested that arsenic and other poisons should be mixed with carbazotic acid. In cases of slow poisoning, the yellow appearance of the person to whom it was administered would at once give rise to a suspicion of something wrong.

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* Nor must they be confounded with petroleum oil, which is now being imported largely from Canada and Pennsylvania. This substance will cause a great revolution in our modes of illumination, especially amongst the poor. It will be treated in a special article.—Ed.

It is a curious fact, that from coal-tar may be extracted the three primary colours, red, blue, and yellow, and these being obtained, every other tint is easily produced by their admixture.

Our space forbids us even to refer to the other modes in which the former by-waste products in the manufacture of gas are utilized. We must now proceed to the next division of our subject—RAGS. We have spoken above of Baron Liebig's proposition to measure the civilisation of a country by the amount of soap which it consumes. We think a better standard of a nation's progress would be the value which it attaches to rags, for, as Dr. Lyon Playfair observes, it is quite true that as nations rise high in the world they appreciate the value of rags more, and are willing to pay a higher price for them from other countries where their value is not appreciated. First and foremost of the many applications of this humble material is the manufacture of paper; for this purpose we buy from other nations no less than 15,000 tons of rags annually, besides using up four times that amount derived from the waste of our own population, representing a money value of rags equal to £700,000. Within the last ten years, paper has been manufactured from numerous other materials, but nothing has yet been found out which can in any way compete with rags in strength of texture or beauty of quality. The manufacture of paper scarcely comes within the limits of the present article, but we may refer to a very valuable improvement which has been effected within the last few years in connection with this product. Mr. Gaine described a process by which ordinary unsized paper could be converted into a material similar to parchment, by a momentary immersion in sulphuric acid of a certain strength, and more recently Messrs. De la Rue and Co. have taken up the manufacture of this parchment-paper commercially. The transformation effected is very striking. A sheet of common white blotting paper, which will scarcely bear its own weight when wetted, is converted in a few seconds into a substance possessing all the properties of ordinary animal parchment, and so strong that it is only torn with great difficulty. The change is more remarkable inasmuch as no chemical alteration has taken place; the acid simply produces a molecular change, and is entirely washed away from it as soon as the desired effect is produced. The applications of this novel material are very numerous; its great strength (nearly double that of parchment), and its indestructibility by water or moisture, render it a valuable material for legal documents, such as policies of insurance, scrip certificates, deeds, agreements, &c. It is also used to replace vellum in bookbinding, and takes the place of ordinary paper in schoolbooks, and other books exposed to constant wear. The manner in which it bears both oil and water colours renders it of value for artistic purposes; the chemist now employs it largely for the new process of dialytic analysis, and ladies use it extensively to replace bladder in covering preserve pots, &c.

But there is another class of rags—those from woollen materials—which cannot be thus employed for the purposes of the paper maker. Our readers are probably aware of the transformations which cast-off cloth garments undergo; their change into "mungo," "shoddy," and "devil's dust," and their re-appearance as "ladies' cloth;" their subsequent degeneration into druggets, and final utilization for ornamenting our walls in the form of flock paper. These we pass over, and will trace the history of woollen rags after they have thus been tortured and wrought into every textile form which the ingenuity of manufacturers can devise. The fibre of the wool may have become physically completely broken up, and disorganized by repeated treatment, but its chemical value remains unaltered, and the large amount of nitrogen which it contains is too valuable to be thrown away. Tons upon tons weight of this woollen refuse are sold for manure, and its excellent properties in this respect are well shown by the perfection of the early brocoli which is supplied so plentifully to the London market from Cornwall.

The class of goods called muslin-de-laine for a long time baffled the waste product utilitarian. The cotton fibre was valuable, and the woollen fibre was valuable, apart, but the difficulty lay in separating the two. Either of them could be destroyed by chemical means; thus, steeping the mixed fabric in acids converted the cotton-weft into sugar, when the wool was left available; and, on the other hand, an immersion into an alkali dissolved out the woollen-warp and left the cotton. But the manufacturer was not satisfied with this; he wanted both fibres; and Mr. F. O. Ward has lately introduced, and illustrated in the chemical department of the International Exhibition, a most ingenious process by which this desideratum is accomplished. He takes the mixed fabric and subjects the rags to the action of steam at a pressure of four or five atmospheres. The effect of this is to char the wool, rendering it very friable, whilst the cotton is not in the least injured. The action over, the rags are beaten and sifted, when the cotton is left behind in the fibrous state, whilst the brittle matter into which the wool has been converted separates in the form of powder. The cotton, being as firm and as strong as ever, may be applied to a variety of purposes: some very excellent paper made of cotton separated in this manner is shown by Mr. Ward; the wool is sold as a manure, under the name of "crenate of ammonia."

But woollen refuse can be applied to higher purposes than forcing early cabbages; the chemical manufacturer, utilizing in another way the nitrogen which it contains so plentifully, throws it into his cauldron, and stews it down with pearlash, horns and hoofs of cattle, old iron-hoops, blood, clippings of leather, and broken horse-shoes—when it produces the beautiful yellow and red salts, known as the prussiates of potash, magnificent crystals of which may be seen in the Eastern Annexe. From these salts, the rich and valuable pigment, Prussian blue, is made; and under this form our old rags start upon a fresh career of beauty and usefulness, forming in their turn other waste products which are again seized hold of by skilful intelligence, and re-utilized.

We now approach the vast and important subject of BONES. The uses to which these are applied are endless. Their mechanical applications for knife-handles and similar purposes do not require more than a passing reference here, but we may state that the quantity annually imported into this country represents a money value of £400,000. Chemically speaking, bone consists of a little more than half its weight of phosphate of lime, and about a third of its weight of cartilage, the remainder being made up of earthy matters unimportant for our purpose. The applications of each of these constituents of bone are numerous: the cartilage is capable of being extracted by boiling water under pressure, being converted into a gelatinous substance, and is then used in large quantities by the calico-printer for stiffening the fabric. The substances known to housekeepers as gelatin and calf's-foot jelly usually consist of this extracted cartilage in a purified form. Isinglass is quite a different substance in its origin, although, chemically speaking, only gelatin. It is prepared from the sounds of certain species of sturgeon; and, from its somewhat high price, has long tempted manufacturers to produce an imitation in ordinary gelatin. The success which has attended this endeavour may be seen by an examination of several cases in the Eastern

Annexe. Viewed as an attempt to endow the humble gelatin with some of the elegance and refinement of its more costly competitor, these endeavours deserve all the success which has attended them; but, in the hands of some retail sellers, this legitimate imitation is often palmed off upon the public as genuine isinglass, when it assumes the character of an unjustifiable imposition.

When bones are heated without access of air, the organic matter of the cartilage is decomposed—oily products passing over and a black carbonaceous residue being left. This is known by the name of bone-black or animal-charcoal, and consists of carbon in an extremely fine state of division diffused through the inorganic constituents of the bones. Bone-black has a great affinity for several organic colouring matters, and is extensively used for decolourizing syrups, sugar, and other things. If a solution of dark brown sugar be filtered through a layer of bone-black it passes through perfectly bright and colourless; port-wine may in a similar manner be obtained as colourless as water, without its flavour being much impaired. The oil which distils over during the operation of calcining is known in commerce as "Dippel's animal oil;" it contains aniline and several other basic bodies, and can be employed for the production of colouring matters in the same way as coal-tar.

The subject of artificial manure is one which has received great attention of late years. Chemists have discovered that the earthy constituents of bones form one of the most valuable foods of plants, and to supply the soil of England with the earthy phosphates which are annually removed from it by cereals and other crops, manufacturers now not only make use of recent bones, but avail themselves of the rich store of phosphatic wealth existing in the fossilized remains of extinct animals. The so-called superphosphate of lime consists of calcined bones, or coprolites,* which have been reduced to fine powder and then treated with sulphuric acid; part of the lime is removed by this process and the remaining superphosphate is obtained in a form which is readily assimilated by plants.

The manufacture of phosphorus — "that dark, unctuous, daubing mass,"—which has now become so important and universal an agent of civilization, is the last product from bones which claims our attention. It is prepared from the phosphoric acid contained in bones by heating it to a very high temperature with charcoal. The five equivalents of oxygen contained in the phosphoric acid are removed by the charcoal, and the phosphorus distils over. The crude product is afterwards purified by distillation and squeezing through chamois leather. One of the largest firms for the preparation of this element, Messrs. Albright and Wilson, of Oldbury, exhibit a most interesting case illustrating this manufacture, the beautiful semi-transparent, wax-like appearance and the large blocks in which it is produced are very accurately illustrated (phosphorus itself being inadmissible in the building).

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* Coprolites are supposed to be the petrified dung of reptiles.

The great consumption of phosphorus is of course in the manufacture of lucifer matches; in this, two difficulties have to be contended with, phosphorus being the most inflammable body known, and also one of the most poisonous. Numerous had been the attempts to overcome these difficulties in the manufacture of this useful though humble commodity, but the liability to explosion, and the terrible disease to which the workmen who inhale the phosphuretted vapours are subject, seemed scarcely capable of being obviated, when Professor Schrötter, by one of the most remarkable discoveries in modern chemistry, effected an entire revolution in the manufacture. He discovered that when common phosphorus was heated for some time in a close vessel to a temperature of 470° F., it underwent a complete alteration in the whole of its physical characters. From a white, waxy, crystalline body, soft and flexible as lead, it became a deep red, amorphous, opaque mass, hard and brittle as glass. The white phosphorus quickly ignites by mere exposure to the air; the red phosphorus will not ignite spontaneously, and may be packed up in boxes, in the dry state, without any danger. The white phosphorus is as poisonous as arsenic, and has a strong garlicky smell, whilst the red is without odour, and has no poisonous properties. The former is luminous in the dark, and melts at 108° F., whilst the latter is perfectly illuminous, and requires a temperature above 500° F. to melt it. Lastly, the white is freely soluble in various liquids, whilst scarcely any known solvent will touch the red modification. In spite of these striking differences, the red phosphorus answers quite as well for match making as the common sort, and as the transformation may be effected with very little trouble, there is no doubt that the harmless variety will, in course of time, entirely supersede the dangerous variety.

Considering the frightful disease which attacks and destroys the jawbones of the workpeople employed in making common matches, and at the same time their highly poisonous properties, we think it the duty of every person to encourage to the utmost the manufacture of matches made from red or allotropic phosphorus. Of these, two varieties are at present before the public. One kind is exactly like the ordinary match in which the oxidizing material and the red phosphorus are mixed together, and put on the tips of the splints, differing therefore from the common kind only in being non-poisonous. The other variety of match is a very beautiful invention. It is called the safety match, and well deserves its name. In our last number (page 522), we gave a short notice of this invention, and we will therefore only briefly refer to it here. The oxidizing material alone is put upon the match, the red phosphorus being mixed with emery, and pasted on the side of the box; the match is therefore not a match until it is brought in contact with this friction-paper, and the splints may consequently be trampled upon and littered about the house with perfect impunity. No accidental ignition can possibly take place.

We have thus briefly sketched a few of the valuable applications of substances which some years ago were looked upon as utterly valueless. Coal-tar, rags, and bones, rise from the sewer and dust-heap, and are transformed by chemistry into costly luxuries, or necessaries of civilization, giving employment in their transformations to a large number of our working classes. Necessary limitation of our space has compelled us to omit all reference to other waste products which are now almost as extensively utilized; but an attentive examination of the magnificent and unrivalled display of chemical manufactures now collected together at South Kensington, will convince the student, that to the chemist there is no such thing as a waste product, that which is so designated being to him a coffer of untold wealth, ready to yield up its treasures to any one applying to it the master-key of knowledge.

No. IV.

THE PHILOSOPHICAL INSTRUMENTS.

BY JAMES BREEN, F.R.A.S.

SINCE the Exhibition of 1851, the improvements in philosophical instruments have been sufficiently various and important. Those which are now universally known were then undreamt of. The stereoscope has come into general use, and instead of the ghastly representations given by the daguerreotype process, we have now solidity itself pictured forth in plain black and white by the assistance of this little instrument. The collodion process, with which it has been accompanied, has reached the utmost perfection. Photographs of the solar spots have been taken as it were in relief,—transferred by electro-metallurgy to a solid form, and, dispensing altogether with the engraver's aid, printed from in the ordinary manner. The binocular microscope has given a fresh impetus to the study of nature in its most minute and intricate forms. Telescopes, indeed, there were in abundance, and good ones too, at the last Exhibition, but they have since been exceeded in power and excellence, although, with the exception of Foucault's successful contrivance of silvering a parabolic glass surface, nothing novel has been introduced in their construction. In the matter of reflecting telescopes with metal mirrors, the movement has been retrograde; but even this, perhaps, has been judicious. At the epoch of the Exhibition of 1851, Lord Rosse's six-foot reflector was in full operation—disclosing the wonderful spiral structure of several nebulæ, resolving others, and thus connecting them, in different respects, with the form and nature of our own Milky Way. But the labour of years bestowed upon its construction, and the difficulty of keeping its polished surface in proper condition, have not been found sufficiently fruitful in results to warrant the extension of this description of telescope. Only one telescope of large dimensions has since been constructed on this plan,—the four-foot mirror of Mr. Lassell, from which, doubtless, by aid of the clear sky of Malta and the long experience of the maker and observer, great results may be anticipated. It is remarkable, that it has been the *makers* of reflecting telescopes who have been most successful in celestial discovery,—the two Herschels, Lord Rosse, Mason, and Lassell, are striking instances of this,—but the care required to keep them in working order, already alluded to, has caused astronomers to have recourse once more to the original refracting telescope, and the latter has gained considerably by the preference. Separate instruments for meridional observation (on a large scale) do not figure at the Exhibition of 1862. Thanks to the present Astronomer Royal, the transit instrument and mural circle have been united into one solid apparatus, with which a single observer can do the same work much more satisfactorily than two on the old system, and register the right ascension and declination of an object with the same ease and equal certainty as on the ancient plan.

The electric telegraph is now a domestic institution, vastly simplified, but yet capable of further improvement, particularly in the insulating of the submarine cable; for out of 14,000 miles already laid down, only 4,000 are stated to be in working order.

It would be impossible, within the limits of a short summary such as the present, to go *seriatim* through the various objects exhibited by one hundred and fifty different inventors and manufacturers. In those articles where taste and ornamentation are most in vogue, such as opera-glasses and optical toys, the British collection is as showy, and, we believe, much more solid than those of other countries. It is interesting to notice the most ordinary applications of science; how some dozens of spectacle-glasses are ground and polished at the same time—arranged and fixed around a convex or concave disc,—and how a rough lump of steel is punched and worked, until, without joint or soldering, it comes forth a spider-web frame for those lenses, such as Ariel might give, or Cinderella receive. In the higher branches of optical art, where the brain is equally potent with the fingers, we miss many names familiar in 1851. Merz, of Munich, who gained the council medal at the last Exhibition, is not represented in the present building, although, from the fine collection of telescopes which he is now constructing, he might easily have spared a specimen. Ertel, to whom, for his fine graduations, the jury awarded the great medal in 1851, but who, nevertheless, by a decision of the council of chairmen, only received the ordinary one, is equally invisible. Troughton and Simms, to whom the same thing happened, are also unrepresented; and the names of Lerebours, Secretan, and Steinheil, do not appear in the catalogue. Only one specimen of Foucault's mirrors, and this of small dimensions, appears at the present international show. The United States, which, on the last occasion, contributed so much that was new and interesting—methods of recording transits, electric telegraph apparatus, photographs of the moon—do not send a single article to classes 13, 14, or 15, and yet the excellence of Alvan Clarke's telescopes is duly appreciated in this country. Neither the large telescope of Professor Amici (Florence), of $17\frac{7}{10}$ inches aperture, nor any other of the splendid list of his scientific instruments given in the catalogue, arrived, although they had been eagerly expected, at the International Exhibition.

Still, however, enough has been exhibited to show the progress of science during the last ten years. The large equatorial made by Grubb, of Dublin, strikes us by the solidity and convenience of its fittings; the diameter of the object-glass is twelve inches, and, should it be worthy of the mounting, will certainly make a noble instrument. The mere metal-work is, however, a subsidiary affair in a telescope—what is most required is perfect and colourless definition, and this is only to be attained by the purity of the glass and the accurate form and complete polish which the artist bestows upon the four spherical surfaces of the crown and flint lenses. The finish of Cooke's instruments is well known. His principal one is a telescope of eight inches aperture, equatorially mounted and furnished with a very solid base. The conveniences for motion in right ascensi [illegible] tion are excellent; the hour circle is moved by clockwork, which, as he is also an exhibitor in the department of Horology, may be expected to be perfect. This apparatus, whilst in motion, keeps the telescope always pointed to the same celestial object. The other telescopes which he exhibits are smaller, but the fittings and brass-work are in all cases very fine. Dallmeyer exhibits some astronomical telescopes in which the stand and slow-motion apparatus are very commodious. Wandering about the cases in the gallery, we perceive many fine telescopes of from one to five foot focus, and fixed on stands of all descriptions—nothing novel in design, although perfect in manufacture. Of the object-glasses (which are not exposed to view) we can form no opinion; but, considering their small size and the consequent ease with which they are made, it is almost certain that they are in all respects equal to the instruments of which they constitute so important a part.

The gem of the Exhibition, in this department, is the great 28-foot telescope belonging to J. Buckingham, Esq., C.E., who has fitted it up for his own private use, and has himself devised and manufactured all its various and novel machinery. The object-glass of twenty inches aperture is the largest *successful* attempt that has hitherto been effected. It is the work of Wray, and has been ground and polished to the true curves by his improved methods; speaking admirably for the perfection of the system, as the surface does not show the least *grain* when examined with a microscope, and the chromatic and spherical aberrations are quite corrected. Whilst amateurs and observers have worked their own mirrors with *one* surface, it has been reserved for opticians *proper* to produce the perfect object-glass of *four* or even *six* surfaces. Few can conceive the difficulty of producing an achromatic lens of twenty inches diameter—the slightest deflection from the true figure, produced by an extra stroke of the polisher, renders the glass quite worthless. It may be stated that the most powerful refractor hitherto in use (if we except that made, during the present year, by Alvan Clark, of 18½ inches) is the 16-inch, by Merz, at Pulkowa; but the light-grasping power of this latter (varying as the squares of the diameter) is only as 256 to 400, in comparison with that here exhibited; so that when the present instrument is brought into operation, we may expect many discoveries to be made in the constitution of those faint nebulæ which Lord Rosse has rendered celebrated. This telescope has as yet been comparatively untried, but it is to be hoped that the vast amount of skill, labour, and capital employed in its construction will lead to many important results. The method of mounting is very commodious—all the clamping and slow motions can be effected from the eye end, and the declination circle is intended to be read off from the same part. In the same case in the gallery in which this great object-glass is exhibited, there are other specimens of lenses, also ground and polished by Wray, all of which (including a 9-inch and 5-inch glass) have been equatorially mounted by Mr. Buckingham for his particular use. The simplicity and steadiness of the portable stand, and the beautiful workmanship of the 7-foot telescope, will be much admired. We may congratulate Messrs. Buckingham and Wray upon their remarkable success in this branch of optics, and upon the introduction into England of a perfection in telescopes, both as regards size and capability, which had hitherto been monopolized by the Munich artists.

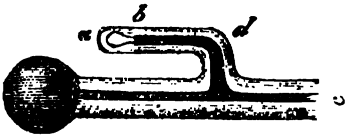
The difficulty of obtaining a fixed position, either for an observer or his instrument, on board a rolling ship, has often been endeavoured to be rectified, but hitherto without success. Chairs, suspended like a chronometer in numerous gymbals, have not been found sufficient to give the necessary steadiness. Peg-tops, with a plane mirror on the upper part, spun on the deck of a ship, have been used in order to give a fixed horizon. Professor Smyth has turned the gyroscope, or rather the principle of free rotation, to account in an instrument constructed by him, and tried with success on his journey between Leith and St. Petersburg. With this gigantic instrument, which required to be set in motion by the combined action of all hands on board ship, he was enabled to keep an instrument directed to any heavenly body notwithstanding the rolling or pitching of the vessel. The utility of this invention will be readily understood by those who have endeavoured to observe the occultation of a star or of Jupiter's satellites on the deck of a sailing or steam vessel. With a similar apparatus he is able to register the degree and effects of all those motions, or to show any two of them combined.

When Oersted perceived (in 1819) that a magnetic needle suspended freely could be turned to one side by the transmission of the electric fluid passing through a wire parallel and near it, no matter at what distance the battery was placed, the telegraph was virtually discovered. It took long years, however, to realize this invention; to find a fitting battery; a perfectly insulated wire; a convenient code of signals. During the few years previous to the Exhibition of 1851 this science made immense progress. Not only were telegraphs then transmitting messages, but actually printing them on ribbons of paper, and the electric current had even been used in recording the passage of a star across the wires of the transit-instrument; thus throwing the ear out of employment altogether, and bringing the sense of touch into operation instead. Since that time the endeavour has been to simplify the alphabet, to obtain a good working electric current—to have a perfectly insulated line of wire, which, by their united action, would supplant the letter-carrier and take the place of the Semaphore, equally regardless of tide, storm, or hazy weather. The labours of Bright, Walker, and Wheatstone have resulted in a degree of excellence which can scarcely be surpassed; one has only to enter the nearest telegraph-office and have his message transmitted to the most distant county of England in a few moments, in order to be apprised of this fact. Further economy in the working, and still greater celerity, appear, however, to be the aim of the telegraph engineer. In one respect these endeavours must command our liveliest sympathy. The most simple system of train-signalling will assuredly be found to be the best not only in the working but in the less liability to get out of repair. Tyer exhibits an instrument which can be worked by the most unskilful hands, and by means of a gong, a bell, a red indicator and a black indicator, gives all the signals having reference to the safety of the train, and cannot by any possibility be mistaken. One condition necessary to be observed, and which, if strictly adhered to, would prevent numerous accidents, is that "no signal is to be considered complete until the reply has been received." Allan exhibits his Automaton Telegraph, in which several novelties are introduced. In the first place, any person sending a message intended to be confidential, and having the cipher in his possession, punches the dots separately on a ribbon of paper at the signalling-office, and this paper being passed over the tooth of a small rotating spur wheel, electrical contact ensues at the different punctures, which is duly answered by a similar puncture on a similar ribbon of paper at the *receiving* office. By this method it will be seen that the signalling or recording clerk is no longer necessary,—the slips of paper are put into the machine at one office and are instantaneously reproduced on the paper at the other extremity. The punched hieroglyphics are delivered to the person for whom they are intended, and the telegraph clerk is completely ignorant of the purport of the message. Both the positive and negative electric currents are used for marking, thus causing a saving of 30 per cent. in the number of currents sent through the wires. In Allan's composing-machine the Morse system of dots and dashes is altogether rejected, and the system of dots alone made use of—the number of dots forming any letter being punched on the ribbon at a single operation by merely touching one of the thirty keys of an instrument arranged like a piano. One of the particular advantages which the system possesses is that the ribbon of paper at the sending end may be passed through the apparatus several times, always reproducing a similar one at the receiving extremity, and may thus be a source of economy where numerous copies of the same despatch are required to be delivered at the same time—as, for example, at various newspaper offices. The various letters are, however, sent as rapidly by Henley's more simple machine, which prints by dots and dashes. Probably, Hughes's American printing telegraph, in which the letters are printed in Roman type at once, will eventually come into general use.

Of all the numerous trophies in the nave of the Exhibition, the holophotal light-house revolving apparatus of Messrs. Chance is the most dazzling, and one regrets that there is not an opportunity of witnessing the flashes of light which it would send forth were the building in a state of darkness, and the great lamp at its centre duly burning. How different from the first attempts at light-houses—where a fire of flaming coal or wood warned the mariner of his approaching danger, or even from the feeble light of a few candles, without either metal-reflector or "bull's-eye," which for half a century surmounted Smeaton's noble structure. Each of those curved and annular prisms and lenses are ground and polished with mathematical exactness in order to reflect and refract, and so economize every ray of light proceeding from the four concentric-lighted wicks, and send them far and wide round the horizon. With one of those massive glass cages the light may be seen at a distance of thirty miles. The dioptric light-house apparatus, although often thought of, has only been successfully realized within comparatively few years, and that mainly through the exertions of Fresnel. The combination of metal reflectors and lenses proposed by that eminent philosopher, who busied himself as much with the humble improvement of the lamp itself as with the deeper researches on the form and arrangement of the lenses, is, however, here much simplified, and glass is made to perform the whole duty. The perfection to which the manufacture of this material has been carried, and the improved plans introduced by Mr. Stephenson in the arrangement of the prisms by which the divergent rays of the flame are gathered up and distributed in one uniform horizontal beam, have fully proved the excellence of the change. The lantern revolves on its axis by means of clockwork machinery, which keeps an uniform rate of motion, and by the number of flashes emitted the sailor is able to tell the name of the particular lighthouse to which he is near. Among other articles exhibited by this firm, we might point attention to the discs of glass of twenty-five inches in diameter, prepared for optical purposes, and from which it is to be hoped that, if perfect, they may speedily be worked up into the object-glass of a large refractor.

When magnetic observatories [illegible] was necessary for an observer to be constantly in attendance, in order to register the different fluctuations of the magnets. Mr. Brook hit upon the happy idea of applying the photographic process to this end, and at the last Exhibition his apparatus for this purpose was in full work. Similar machinery, as arranged by the late Mr. Welsh, and now in use at the Kew Observatory, is here exhibited, and it will be seen with what simplicity the light coming from one fixed, and another hemispherical mirror, attached to the magnets, impresses two images on a waxed paper photographically prepared—one of which gives a fixed line, and the other, of course, moves according to the oscillations of the magnets, the distance between the two showing the amount of the latter. This principle has also been applied to registering the fluctuations of the barometer and thermometer, and is preferable to any other, —in the former case, being much more safe and simple than the numerous self-registering mechanical apparatus here exhibited, for showing the height of the mercury during the twenty-four hours, in all of which friction takes place more or less.

The ozonometer of Dr. Lankester is an ingenious adaptation of the same self-recording principle, only that, in this case, it is the life-giving properties of the atmosphere (and not solar or artificial light) which leave traces on the prepared paper. The effect of this element is shown in a large diagram, drawn up by the same authority, representing the various tints of slips of paper exposed during different states of the weather; and to the meteorologist this is as useful, and should be as strictly attended to, as the weight, temperature, or humidity of the atmosphere. To those who have used the ordinary maximum thermometer, with an index floating on the mercury, which is only too liable to get out of order, the self-registering maximum thermometer of Professor Phillips, consisting of a broken column of mercury, will be a great boon. The mercurial minimum thermometer, of Casella, is another great improvement; in this case advantage is taken of the adhesive property of mercury for glass in vacuo, and also of the fact, that when two tubes are joined to one bulb, the mercury will rise in the larger by expansion, and fall in the smaller by contraction. He therefore makes a branch, *d*, to the ordinary thermometer, having a flat diaphragm at *b*, the inlet to which is *larger* than the bore of the long tube, *c*. The mercury in cooling withdraws the fluid in the indicating stem only, whilst on expanding, it flows into the passage where it finds the least pace; in other words, the mercury in the long tube cannot



rise, but *will* fall. Mr. Johnson shows a novel instrument for registering deep-sea temperatures, where advantage is taken of the different degrees of the expansion of metals. Riveting two thin pieces of brass and steel together, he has contrived means to register the effects of the small curvature which the combined metals must undergo by a change of temperature. By this method the pressure of the sea on the bulbs of self-registering thermometers is got rid of, which is quite destructive of delicacy at immense depths. The same gentleman shows his instrument for recording deep-sea soundings, in which the fact that water is slightly compressible is ingeniously applied.

MM. Negretti and Zambra exhibit a deep-sea sounding thermometer on quite a different construction to that of Mr. Johnson. In their instrument the bulb of the thermometer is enclosed in a second cylinder partly filled with mercury *in vacuo;* the pressure of the water at great sea depths exercises its influence on the latter—the internal bulb being quite free from pressure on this account.

Of the ordinary instruments of science—microscopes and microscopic preparations—the collection shown in the French and English departments is excellent. It would be invidious to point out any one maker among so many known to fame. Single and binocular and museum microscopes are here—from the cheapest to the most expensive and complicated forms. We may say the same of all the ordinary surveying, nautical, and drawing instruments, such as theodolites, sextants, compasses, and levels. Among the newly invented microscopical apparatus, the visitor will perceive, in Ross's case, the hemispherical condenser of the Rev. J. Reade, from which, by means of double stops and hemispheric lens, one, two, or three apertures may be obtained, and the linear markings, no matter at what angles, on test-microscopic objects, obtained by means even of an ordinary microscope. The application of aluminium to small telescopes and other instruments intended to be held in the hand, renders them very commodious; a sextant here exhibited, only weighs one-half of a similar one constructed of the ordinary metal. A contrivance for facilitating the approximate solution of problems in spherical trigonometry (exhibited by Moore) will be found useful to the seaman. The apparatus for spectrum-analysis invented by Crookes has now become one of the necessities of the laboratory and the observatory, and replaces the simple prism and theodolite originally made use of by Fraunhofer. We trust that the inventor may soon set at rest the disputed question of the spectra of stars which has within the last few months so much engaged the attention of astronomers.

In some departments and countries the chronometers are ranged under the head of Philosophical Instruments. This is by no means a mistake, for to the weatherwise, the star-gazer, and nautical man, a good chronometer is as essential as scales, weights, and measures to the chemist. Two of our greatest living astronomers, Professors Hansen and Bond, were originally in this profession.

Whilst the English department is full of the admirable mechanism and inventions of our Dents, Bennetts, Frodshams, Losebys, &c., we perceive that other countries have not been behindhand. Germany has adopted Hartnup's excellent balance. Hohwn, of Amsterdam, exhibits a compensation of his own invention, whilst a small pocket chronometer, of exquisite workmanship, exhibited by Baume and Lezard, which has been compared at the Geneva Observatory, appears to have kept its rate with extraordinary accuracy, and reflects great credit on the manufacturers. The ships' chronometers of Grandjean also show the progress which this branch of manufacture has been making in Switzerland, where goodness and cheapness are combined. The nautical astronomer here finds plenty to engage his attention in every department of his occupation.

MISCELLANEA.

THE ALBERT MEMORIAL.

THE Commissioners appointed by her Majesty for the purpose of erecting a monument in memory of the late Prince Consort have decided, after mature deliberation, and amidst the expression of the most conflicting opinions, to raise a suitable memorial group, which is to be placed in a building to be devoted to purposes of science, art, and literature. This determination will, we believe, meet with the cordial approbation of all who know anything of the desires and aspirations of him in whose honour the memorial is to be erected; and such a monument will present a suitable contrast to the numerous obelisks, needles, and statues which have from time to time been raised to the memory of the wise and good.

We have but one observation to make upon the project, which has our best wishes for its success.

If the building and its adjuncts be so ordered as to be useful to the metropolis only,—in fact, if its vital functions, so to speak, are to be purely metropolitan, well, then we wish it may prosper, and that the inhabitants of London and its vicinity will give it every support and countenance.

If, however, it is to be *national*, and if provincial towns (where encouragement to science and art is so much needed) are to participate in its advantages, and it is destined to form a great centre to the scientific and other associations which desire to be interlinked with it,—then we not only hope, but feel very confident, that it will meet with support from every town in the British empire, however large may be the sums that have already been subscribed or voted for local memorials; and then, indeed, it will become a fitting monument to the memory of the good Prince whose life and acts it is designed to perpetuate.

OUR SCIENCE SCHOOLS AND CLASSES.

THE zealous and efficient teachers whose services have been enlisted in the cause of Science, chiefly in consequence of the tempting inducements held out to them by the Committee of Council on Education, have just cause to congratulate themselves, and to look with pride upon the results which, year after year, are being attained through their agency.

Mr. Ralph Tate, of Belfast, for example, who appears to possess as great tact in giving direction to the intellectual efforts of his students, as he does ability to teach science, will have no cause to regret having undertaken his task, when he counts up the numbers and achievements of his "passed" pupils.

So far as the published records of the Department of Science and Art indicate, his class appears to have existed only one season, during which time his teaching has been most efficient, and the industry of his students highly creditable; for eighty-two o[illegible] [illegible]ed the government examination in geology and mineralogy, and of these, eleven have carried off first-class Queen's prizes in geology (out of thirteen granted all over the United Kingdom), twelve second-class, and fourteen third-class; thirty-seven prizes in all. In mineralogy they have taken twenty-one prizes, six of which are of the highest grade.

Amongst his pupils are men and women, boys and girls, of almost every age, profession, and calling: clerks and their sons and daughters; young women in shops; tradespeople and their apprentices; children of operatives, and operatives themselves; national teachers, Methodist ministers; miners and their sons; indeed it would be difficult to name a trade or profession which is not included in the list of his pupils; and it is a feature worthy of special attention that the most successful have been girls, who have carried off many of the highest prizes.

All these young people constitute so many missionaries who will diffuse a taste for science amongst their friends and relatives, and many of whom will no doubt in their turn become successful teachers.*

Equally, or perhaps still more successful in the results of his teaching, is Mr. John Dowling, of Cork (our Irish friends certainly put us a little to the blush on this side of the Channel), whose pupils carry off no less than sixty prizes; including fifteen of the highest grade in inorganic, and nine in organic chemistry, the remainder being of lower grades in chemistry, and various prizes in the different subdivisions of geology and natural history.

Pleasing as such a task would be to us, and however richly our science teachers deserve to have their individual successes everywhere recorded, their numbers prevent us from doing them this act of justice; but as far as we are able, we shall afford to their success that publicity and recognition which it deserves, by appending to this article a list of those gentlemen whose pupils have taken first-class Queen's prizes, with the name of the town in which each resides, and the subject or subjects in which his pupils have been successful. We also add the names of those students whose talent and assiduity have enabled them to carry off the gold medals; and the names of their teachers.

The most successful schools and classes appear to be those in Cork, Belfast, Huddersfield, Wigan, Banbury, Gloucester, Truro, Bristol, Manchester, Oldham, Accrington, Liverpool, and London.

We must, however, repeat the regret expressed in our last article on this subject, that the large towns, such as Birmingham, Manchester, Leeds, Hull, &c., are, comparatively speaking, far behind their smaller neighbours, and we do so notwithstanding a protest which we have received from Birmingham, but which, unfortunately for the protester, fully corroborates what we have stated on the subject.

In our number of last January we said, that whilst in such places as

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* So far, we believe, no females have attended the November examinations at South Kensington for the purpose of graduating as teachers; and we again earnestly recommend this subject to the consideration of the Committee of Council on Education. If it be found impracticable to afford an asylum to young girls desirous to visit London for this purpose, it would be no difficult matter to let them pass the teacher's examination at the science school nearest to the place where they reside; and this could be done in May, when the general examinations of students take place throughout the kingdom.

Dedham, &c., there were *classes*, and *schools* in Banbury and Wigan, yet there were not even classes in Leeds and Hull; and that in Manchester and Birmingham a commencement had only been made by individual teachers, but that there are no recognized *public schools*. To this statement our Birmingham correspondent takes exception, affirming that science classes have been established in connexion with the Midland Institute since 1854, and the writer seems to think that they have been successfully conducted.

So far as the expression, "recognized public schools," is concerned, we may say, that although it was intended to refer to schools specially devoted to science-teaching only—"science schools," in fact—we must apologize for not recognizing the connexion of the science classes with so valuable a public institution as the Midland Institute, concerning whose operations we treat elsewhere at greater length;* but as regards the more important part of our statement, namely, the position occupied by Birmingham (amongst other places) in the movement, we are bound to confess that a comparison of the details given by our correspondent, with the results of the recent State Examinations, shows that, however humble the position of this important manufacturing town was in 1861, it appears this year to have retrograded still further. With all the resources of the Midland Institute, at which, our correspondent tells us, "800 pupils are receiving class instruction," and notwithstanding that the science classes have been in existence since 1854, only twelve students passed the government examination this year, of whom four have taken inferior prizes. A comparison, moreover, of the results of this with those of last year reflects very unfavourably, in other respects, upon the condition of these classes. We cannot suppose that the teacher is responsible for this state of things, for he holds high certificates, and is spoken of in terms of praise by the committee.

Having been compelled to say thus much (and we might have said more) in defence of our position, we may now add that we feel sure that if greater publicity were given to the advantages to be derived from joining the science classes, and if our correspondent would exercise his influence (which is not inconsiderable, for we understand that he takes the lead in all intelligent and progressive movements in Birmingham) in their favour, a science school would spring up and flourish in his town, which would be second to none in the kingdom.

The new school, inaugurated by Earl Granville, in Liverpool, last autumn, has been moderately successful; for although the session was a short and imperfect one, forty-three out of about a hundred students presented themselves for examination; of these forty-one passed, and seventeen took prizes of various kinds, chiefly, however, as might be expected, of the lower grades.

In the first and second Numbers of this Journal we drew attention to the advantages, pecuniary and otherwise, derivable from a connexion with the department of Science and Art, by teachers and students of science; and feeling that too much publicity cannot be given to the benefits offered to those who are disposed to join in this excellent movement, we will once more refer to the career which lies before those who possess and feel disposed to take advantage of scientific attainments; and it must be clearly understood that the following remarks apply to young persons of *average* ability; for there is no limit to the success of a very able and persevering teacher.

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* See "Provincial Institutions and Societies."

Let us suppose that a young man of eighteen joins a science school in his town, and that, taking up a single branch of science—Zoology and Animal Physiology—he attends two or three courses of evening lectures.* He must be very dull indeed if he does not succeed during this period in obtaining first-class prizes in both subdivisions of his subject (to say nothing of bronze, silver, or gold medals), and he may then aspire to become in his turn a science teacher. This he does by passing his examination on the subject in question at South Kensington, Government paying his travelling expenses and the cost of his living in London.

Here he may obtain a first, second, or third class *teacher's* certificate; and should he not be satisfied with one of a lower grade, he may "improve" it by presenting himself (always at the expense of the State), time after time, until he fairly succeeds in securing a certificate of the highest grade, and the emoluments accruing therefrom.

Our candidate has, we will suppose, after two or three examinations, secured a first-class certificate in Zoology and Animal Physiology (having meanwhile conducted a small class, and received the grants which accompany one of a lower degree),† and, as we have hardly treated him in a complimentary manner, in supposing such repeated efforts to be needful in order to secure a first-class teacher's certificate, we will take it for granted that, during his probation, he has also obtained one of the *second* degree in botany and Vegetable Physiology; and that he has a small class, say of ten pupils in each subject, four or five of whom have passed the government examination, and three have obtained respectively a first, second, and third class Queen's prize in each subject. During the year, when he shall have obtained these not very brilliant results, he will be entitled to draw from the coffers of the Treasury the sum of £42, besides charging what he may consider fair to each of his students, or receiving a salary from the institution with which his classes are connected.

And all this he may effect—his scientific education, as well as his teaching operations—without the slightest interference with his business pursuits, but only by a wise and elevating employment of his leisure time. So much for the exertions of a young person of ordinary abilities. A successful teacher may earn hundreds of pounds per annum, and may (as many doubtless will) at the same time attain a high position in society and in the State.

With these few remarks we once more dismiss this important subject, and should any of our readers be desirous to aid the movement, either as teachers, students, or promoters of schools or classes, they will receive every needful information on applying to the Secretary of the Science and Art Department, South Kensington Museum, London. As for ourselves, we shall be most happy to give the scheme itself, or the efforts of individual teachers, every encouragement in our power, and we invite the various institutions to forward us their reports whenever they may deem it to their advantage.

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* His fees, text-books, &c., will cost him *in all* from 10*s.* to 30*s.*, according to the charge made by the committee of the school which he attends.

† Under the new Code certificates of every grade are alike remunerative.

LIST OF SCIENCE TEACHERS

Whose Pupils obtained first-class Queen's Prizes at the last Government Examination.

Teachers' Names.	Address.	No. of Prizes.	Subject or Subjects in which the Prizes were taken.
Angell, J.	Manchester	9	Animal Physiology; Inorganic Chemistry.
Beale, J. H.	Banbury	1	Animal Physiology.
Beesley, T.	Banbury	2	Inorganic Chemistry.
Bentley, B.	Huddersfield (Kirkheaton)	1	Inorganic Chemistry.
Bernhardt, G.	Manchester	2	Geometry (practical, plane, and descriptive).
Birkenhead, E. H.	Wigan	4	Inorganic Chemistry; Mineralogy.
Burchett, R., and Binns, W.	Chester	1	Geometry (practical, plane, and descriptive).
Chadwick, J.	Macclesfield	1	Inorganic Chemistry.
Clement, L.	Burnley	1	Inorganic Chemistry.
Collingwood, Dr.	Liverpool	1	Zoology.
Coomber, T.	Bristol	4	Theoretical Mechanics; Inorganic Chemistry.
Crossley, W.	Middlesbro'-on-Tees	2	Inorganic Chemistry.
Dorrell, J.	Slough	3	Geometry (practical, plane, and descriptive).
Dowling, J.	Cork	27	Mineralogy; Animal Physiology; Vegetable Physiology; Economic Botany; Organic and Inorganic Chemistry.
Eardley, F.	Belfast	3	Magnetism and Electricity.
Easterby, W.	Ripon	1	Theoretical Mechanics.
Hall, T.	London	4	Theoretical Mechanics; Magnetism and Electricity.
Hoffman, Dr.	London	2	Organic and Inorganic Chemistry.
Hudson, Fearnside	Manchester	2	Inorganic Chemistry.
Hudson, W.	Manchester (Eagle Foundry)	1	Building Construction.
Jarmain, G.	Huddersfield	6	Geology; Organic and Inorganic Chemistry.
Jeffery, W.	Gloucester	8	Magnetism and Electricity; Inorganic Chemistry.
Lindsay, A.	Glasgow	1	Animal Physiology.
Maver, D.	Aberdeen	2	Theoretical Mechanics.
Mayer, J.	Glasgow	5	Animal Physiology; Inorganic Chemistry.
Meaden, H. P.	Haslingden	9	Inorganic Chemistry.
Mellor, J.	Manchester (Hollingwood)	3	Building Construction; Geometry.
Mortimer, Dr.	London	3	Magnetism and Electricity; Acoustics, Light, and Heat.
Noble, J.	Halifax	2	Organic and Inorganic Chemistry.
O'Neill, C.	Salford	6	Organic and Inorganic Chemistry.
Pearce, R.	Truro	1	Mineralogy.
Penny, Dr.	Glasgow	2	Inorganic Chemistry.
Rowden, W.	Bristol	10	Mineralogy; Geometry; Mechanical Drawing.
Rüntz, J.	London	1	Inorganic Chemistry.
Tate, R.	Belfast	[illegible]	Geology; Mineralogy; Inor[illegible]stry.

The pupils of nearly all thes

Revised Regulations of the Science and Art Department.

Since the foregoing article was written, we have received a revised code similar in its intention and operation to that which recently caused such excitement amongst "elementary" schools. The changes proposed are as follows:—1. As regards *teachers, a substitution of payments on results for certificate money.* Under the old regulations, teachers were paid a sum of money upon each certificate which they held; this sum varying according to the grade of the certificate, and the number of pupils passed, up to a certain number. Thus, for example, if a teacher held a first-class certificate in Zoology (and subdivision), and a second-class certificate in Botany (and subdivision), he would receive on the former *up to* £20, and on the latter *up to* £15, at the rate of £4 per head on his students who had passed the Government examination in any subdivision of the subjects taught by him. In fact, he would be expected to pass nine students in *some* subject or subjects. In addition he would receive £1, £2, or £3 per student who took a Queen's prize, according to the grade of that prize.

Under the *new* minute the *grade* of his certificate is immaterial; for a teacher holding a third-grade certificate is placed on the same level, or, at least, is paid in the same ratio as one who has a second or even first-class certificate. Under this *régime* the teacher is to receive for *every* student who passes in *each* subject in which the teacher holds a certificate, £1; for every one who is "honourably mentioned" (a new distinction), £2; for every one who takes a Queen's prize, £3, £4, or £5, according to the grade of the prize; but in no case can he receive more than £5 on any one student.

The following statement will exhibit the operation of the change:—

A B holds Certificates—	Value under old Minute.	No. of Pupils to be passed under old Minute.	No. of Pupils under new Minute.
Botany and Veg. Phys. 1st Grade ...	£20	Fourteen in any subject.	Fifty-five in any subject, or twenty-eight "honourable mentions."
Zoology and An. Phys. 1st Grade ...	20		
Geology. 1st Grade ...	10		
Mineralogy, 2nd Grade ...	5		

On the other hand, should the teacher pass a hundred pupils under the old minute, he would only receive £55; but under the new minute he would get £100; or if he passed fifty with credit under the old minute, without their being able to obtain a prize, he would still only obtain £55; whilst under the new, fifty with "honourable mention" would secure him £100.

The prize-money appears to remain the same in both cases.

In certain cases, science may now be taught in elementary schools, which was before prohibited.

The results of the change are so obvious that it appears almost unnecessary to comment upon them.

Under the old regulations the *pecuniary interest* of the teacher would be to take as *many* and as *high* certificates as possible; and to pass only sufficient students (in any subject that was most convenient) to secure him the value of those certificates. Good teachers would be *created*, but without a guarantee that they would teach the subjects upon which they claimed their annuity. This is corrected by the new regulations, which, whilst they still hold out inducement to teachers to become proficient *as teachers*, afford a guarantee to the tax-payer that he is receiving value for his money.

On the other hand, it seems to us that the new code is calculated to lower the *tone* of the movement whilst extending its sphere.

The holders of certificates of all grades being now placed on the same footing, there is no moral nor pecuniary inducement to young men to become proficient in scientific knowledge beyond what is needful for teaching purposes; and men already eminent in science (whose support it is even now difficult to enlist) will probably have greater objections than before to co-operate in the movement.

Again, as it will be the interest of teachers to pass as many pupils of the industrial classes as possible, so it will be the aim of committees to secure the largest attendance of these, even if they must give gratuitous admission. And, although this may serve the end of diffusing useful knowledge amongst the masses, yet it will militate strongly against the foundation of a "self-supporting system of scientific instruction."

However, the operation of the code will soon decide which predominate, its advantages or its disadvantages, as compared with the old code, which has already effected so much good throughout the three kingdoms.

LIST OF GOLD MEDALLISTS.

Science Examinations, May, 1862.

PRACTICAL, PLANE, AND DESCRIPTIVE GEOMETRY, MECHANICAL AND MACHINE DRAWING, AND BUILDING CONSTRUCTION.

Student's Name.	Age.	Residence.	Name of Teacher.
William H. Parker	18	Bristol	William Rowden
MECHANICAL PHYSICS.			
*E. P. Scrymgour	17	London	Thomas Hall
EXPERIMENTAL PHYSICS.			
Jos. G. Clarke	17	London	Dr. Mortimer
CHEMISTRY.			
B. H. Demery	30	Cork	John Dowling
GEOLOGY AND MINERALOGY.			
*John Granger	31	Belfast	Ralph Tate
ANIMAL PHYSIOLOGY AND ZOOLOGY.			
Charles Taylor	12	Banbury	J. H. Beale
BOTANY.			
*W. W. Tyler	26	Coventry	—

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* Those marked with an asterisk are ineligible to receive the medal, being middle-class students over seventeen years of age.

PROVINCIAL INSTITUTIONS AND SOCIETIES.

"LECTURES don't answer," is a remark which we have heard so frequently, that we have almost been induced once or twice to think that they do *not* answer.

A little reflection, however, has shown us, that although some lectures do not, and never will succeed in attracting popular attention, yet there are others, adapted to the tastes and requirements of the public, which have always been tolerably successful and will become more so year by year.

We cannot, in this place, enter upon the reasons for the failure of so many lecture societies, variously known as "Mutual Improvement" societies, "Literary," "Scientific," or "Philosophical" institutions; but it may not be out of place if, before commenting upon some of the numerous reports which lie upon our table, we point out a few of those causes of declension (not of the societies to which we shall refer) that are overlooked by "indefatigable" honorary secretaries, and which dishearten so many zealous promoters of our literary or scientific establishments.

Should any of our remarks be unpalatable to persons who are interested in such societies, we trust that no light or unworthy motives may be imputed, but that credit will be accorded to us for desiring to see the efforts of the young and earnest philanthropist successfully directed.

The courses of lectures that we have found to be the most ephemeral are amongst those desultory ones which are offered to the dwellers in the suburbs of large towns, and villages possessing a commodious school-room.

Lectures of this order have generally for their object the withdrawing of the mechanic or day-labourer from the public-house, and the enlightenment of the sober and industrious artisan.

But let us inquire of any thoughtful person, who is initiated into the working of such societies, in how many instances they are really calculated to effect their object.

To speak within bounds, we think that one half, at least, of all the discourses delivered by inexperienced amateur lecturers are treated better than they deserve when they are "listened to throughout with attention by a respectable auditory;" and it is not a matter of surprise to us that they so frequently afford suitable food for the satirist and novel writer. They represent the waste steam of men whose whole time is spent in worldly pursuits, and who see, or imagine for the time being that they see, in some favourite hero or imperfectly-studied subject, a theme with which they will be able to electrify their neighbours and reform all idlers and dissolute characters in their parish. But such persons know nothing of the character and pursuits either of the intelligent or of the intemperate working classes.

Amongst the former, it would not be difficult to find many who are better able to compose essays upon the subjects treated by our amateur lecturers than are these themselves; and, still more, who, after a hard day's work, prefer staying at home at the season when such lectures are usually delivered, there to enjoy, in the society of wife and children, a "spell" at the *Leisure Hour* or some other cheap "weekly;" a pipe and glass of ale or cup of coffee; or a laugh at the sallies of *Punch* or Lord Palmerston; to the disagreeable alternative of tramping half a mile or so in the rain and snow, and sitting two hours in a damp, ill-ventilated school-room, listening to the crotchets of some gentleman who has probably pirated no inconsiderable portion of his lecture from one of the very publications referred to, and now retails it second-hand in his own improved phraseology.

To us, it augurs well for the "lecture movement" that so many persons are found willing to sacrifice the comforts of home for the purpose of encouraging a well-intended effort to educate their benighted comrades. As to the last-named, they do not hesitate to turn their backs upon such entertainments, which they consider "dry work" compared with the "snug" and its excitements, found in the records of the police or divorce courts, or in the arguments and wise saws of the pot-house politician.

Again, we say, our readers must not suppose that we are decrying those excellent institutions which spring up, here and there, in opposition to the public-house. We are well aware that it is a matter of life and death with which we are dealing, and are determined not to regard it, as do many well-intentioned persons, as one of mere sentiment; but when, on the one hand, we observe, with dismay (as we have unfortunately good opportunities of doing), how the palaces of sin and misery multiply, like gaudy and soil-exhausting weeds in the midst of the young corn, or like great gilt cars of Juggernaut, under whose wheels the infatuated victims cast themselves by thousands; whilst, on the other, we see how ineffectual is the antidote provided against such evils,—the ever-growing strength and stability of the one, and the feeble counteracting influence of the other,—we deem it incumbent upon us to proclaim the causes of failure, even if we are unable to supply a more efficient remedy.

Concerning this, we may have more to say on some future occasion; meanwhile, we can suggest what appears to us a slight improvement upon the system with which we have cause to find fault; namely, the substitution of readings for lectures where suitable lecturers are not obtainable. If the gentleman whose original effusions result only in the production of so much waste-paper, would retire quietly to his study, and, taking up some work of acknowledged merit,—it matters not of what description—poetical, historical, philosophical, or scientific,—nay, even a weekly journal; if he would read and rehearse this carefully twice or thrice, so as to avoid errors in public, he could not fail to afford pleasure to his hearers, for it is always agreeable to listen to a well-read and well-written composition; and he would, moreover, be diffusing a taste for sound standard literature. We believe that, wherever pleasing readers have come forward to provide such entertainments for their neighbours, the movement has proved successful.

And, again, irrespective of those clever professional lecturers who can at all times attract a goodly number of listeners, rivet their attention and send them home thinking and determined to learn something more than they knew before, there are many persons who, if they would take the trouble to *prepare themselves carefully*, might entertain and instruct a large audience (provided, of course, that they are fitted by education to appear as lecturers) by simply speaking about what they thoroughly understand, or ought to understand; namely, *their own business.*

Let the engineer explain the principles of "Steam Navigation;" the lapidary treat of "Precious Stones;" the soda-water maker, of "Soda-water Manufacture;" the builder, of the "Principles of Roofing;" the photographer, of "the Chemical Agencies of Light;" the chemist, or analyst, of the "Outlines of Chemical Analysis;" the artist, of "Perspective-drawing Instruments;" the glass-dealer, of "Ornamental Glass," and so on. To do this successfully might necessitate a better acquaintance, on the part of the lecturer, with the principles of his business or profession; but this, our readers will agree with us in saying, would be as advantageous to himself as it would be desirable for his hearers' sake. In recommending such a course, we are not only guided by our own experience of what we have known to be interesting to the public, but we are proposing that each one should, in his own humble way, follow the example set by many of our most successful institutions; namely, descend from high-flown, theoretical, and often speculative themes, to the every-day life of his hearers, and seek to create a fresh interest in those objects which come under their daily notice, and are passed by as unworthy of consideration.

The subjects above named, for example, form part of the course delivered before the chemical section of the BIRMINGHAM AND MIDLAND INSTITUTE, one of the most thriving and successful institutions in the country, and, in the pamphlet before us, we find that this section is reported as "still going on prosperously."

Glancing a little lower down, on the same page, we notice that "the Penny Lectures" were attended during the winter term by 117 persons, in spring by 69, and in autumn by 160; and, in the words of the Report, "that the increase of attendance during the current term is mainly due to the subject, 'The Outlines of Chemistry,' which is the most popular."

These outline lectures, it would appear, are "arranged to serve as an introduction to the courses in the class, the 'Penny Lecture' course terminating just before the new course in the class commences." In this extract the reader will find another reason why certain lectures answer when others fail. Those discourses which serve only to interest for the moment, but have no definite object, soon pall the intellectual appetite; but where there is an end to be attained, as in this case, the "working classes" will come to listen and learn, and will even subsequently enter upon a course of laborious study, in order to render themselves masters of some branch of science. There is another paragraph in this Report deserving of special notice: namely, that relating to the botanical class, conducted by Dr. Hinds, as honorary lecturer. It is as follows:—

"The class for botany has, on the whole, made satisfactory progress during the year, except in the number of members, which has not been so good as is desirable. Two classes of students have availed themselves of this class, namely, *one in whose future prospects and requirements a knowledge of botany is desirable or essential*,* an element, perhaps, in some future examination to which the student looks forward; the other composed of those who study botany for its own sake, and desire to increase their scientific knowledge by a study of some branch of natural history. To the former class the Institute affords opportunities of a valuable kind, not to be obtained on the same terms elsewhere in Birmingham. To the latter class the Institute holds out equally useful opportunities, in bringing science within the means of the class of artisans and others almost for whose especial benefit and improvement the Institute arose. This class of students in natural and other sciences is far too small, but it is firmly believed that ultimately the number must increase. The existence in some towns, as Manchester, of a large class of artisans and others who take delight and have skill in natural science, especially botany, shows that this branch of natural history is susceptible of being made useful and popular.

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* The italics are ours.

"It cannot be said that Birmingham artisans have less capacity than a similar class in other towns, and therefore it is hoped and believed that ultimately this class of persons will gradually be found to acquire tastes of a more elevated and classical kind than at the present time."

Of course Birmingham artisans are not deficient in capacity; but perhaps they may not possess the same facilities for indulging in intellectual tastes as are presented to the humbler classes in other towns. Is there a Field Club in connexion with the botanical class of the Midland Institute, enabling the students to watch Nature in the free exercise of her functions; or are their observations confined to the traces of her handiwork as exhibited in the inanimate objects of the museum?

The scope of this Institution is perhaps the most extensive of any of its kind that has come under our notice. Besides numerous courses of lectures, delivered in some cases by men of the highest scientific attainments, there are classes in geometry, English history and literature, algebra (2), advanced and elementary arithmetic, writing, French, English grammar, composition (2), chemistry (several), botany, experimental physics, and the penny lectures and penny readings, *both of which are better attended than all the rest of the classes together* (excluding that in elementary arithmetic, which is numerously attended). There are also a museum, library, and the other adjuncts to such an establishment. We do not, however, see any mention made of classes in zoology, geology, mineralogy, &c., for which there must be great scope in such an important town as Birmingham.

In striking contrast with the proceedings of the Institution just named, we have those of the "YORKSHIRE PHILOSOPHICAL SOCIETY," whose operations are carried on in the city of York. Favoured with one of the most perfect museums in the world, under the guardianship of seven curators, each superintending his own department of science, with an excellent observatory, under the care of a committee of six gentlemen; and, with every advantage that wealth affords, this society maintains a high position amongst those of Great Britain. The lectures delivered during the last session, as well as the "Communications to the monthly meetings," were various and interesting. Amongst the latter are many of general interest, and one or two extracts from the Report will, we think, please our readers better than any further comments of our own.

A Paper on "ALUMINIUM," by W. PROCTOR, Esq., F.C.S. (read March 5th).

"He traced the history of the discovery of Aluminium from the time of Davy to that of Wöhler and Deville, who first obtained it in any quantity, and described the process adopted by the latter chemist for procuring Aluminium by the decomposition of its chloride by metallic sodium. Certain difficulties attendant on this process led Dr. Percy to suggest the mineral called Cryolite, a fluoride of aluminium and sodium, as a source of aluminium.

The process consists in heating the powdered mineral, with common salt and sodium, for two hours in a covered crucible; at its conclusion the metal is found at the bottom of the slag. The price of the metal, when it was first obtained, was £5 to £6 per ounce. In 1856 Deville had reduced it to £3 per ounce, and it is now usually worth 5s. per ounce, although Mr. Gerhard, who is engaged in preparing the metal from cryolite on a large scale at Battersea, stated at a meeting of the Society of Arts, that he had undertaken a contract at 3s. 9d. per ounce.

"Aluminium is a white metal, with a bluish tinge, and a lustre inferior to that of silver. Its specific grav. is 2·6, or about one fourth that of silver, a property of importance, as this lightness causes a given weight of aluminium to go as far in the manufacture of articles as four times the quantity of silver. It is malleable, and ductile, and possesses considerable tenacity; when pure, it is as hard as silver, but it has no great elasticity, and requires rather a high temperature to fuse it. It is not oxidized by exposure to air, even at high temperatures; it resists the action of sulphur and sulphuretted hydrogen, which so rapidly tarnish silver, and is insoluble in any of the ordinary acids, except the muriatic; potass, soda, and ammonia in solution dissolve it rapidly; and the beautiful frosted appearance seen on articles manufactured of aluminium is produced by plunging them for a short time in a solution of potass at blood-heat, and then immersing them in nitric acid.

"It will easily be seen that a metal possessing the properties above described will be capable of many applications, and aluminium has already been employed in the manufacture of a great number of articles. Its chief use, however, will probably be in the production of alloys, as it gives increased hardness to whatever metal it is used with. An alloy of three parts aluminium and 97 parts iron has the brilliancy of pure silver, and does not tarnish. 100 parts silver and 5 parts aluminium form an alloy as hard as sterling silver, and as easily worked as the pure metal. Copper, with a quarter of its weight of aluminium, gives an alloy of the colour of gold, and very malleable. With 20 per cent. of aluminium the alloy is white; and a mixture of 90 parts copper and 10 parts aluminium is harder than bronze, and has been used for the works of clocks and watches. Calvert describes an alloy of 15 aluminium and 78 iron, which does not rust in moist air or water."

Another paper of deep interest was read, April 2nd, by the Rev. J. Kenrick, on the Rev. Mr. M'Enery's "Researches in Kent's Hole, near Torquay." Bearing, as it does, upon the supposed age of the human race, and expressing the opinions of an enlightened clergyman and antiquary, we recommend it to the careful consideration of our readers:—

"Kent's Hole is a fissure in the limestone rock, which belongs to the Old Red Sandstone formation. Its floor is covered with a stalagmitic deposit, under which lies a bed of mud and gravel, brought in by a flood of water. According to Mr. M'Enery, the various contents of the cave follow each other in this order, proceeding downwards from the surface. First, black pottery, with traces of the lathe, human teeth and bones, beads, bone pins, and other articles belonging to the Romano-British period, when the Romans had an encampment on the down above the cave. Lower down were found arrows and spear-heads of flint, and stone axes, among fossil teeth and bones of herbivorous and carnivorous animals, but no pottery or other works of art; lowest of all the bed of diluvial mud, containing merely animal remains, but no works of art, except some flint instruments adhering to its upper surface. Mr. M'Enery's description of the succession of deposits, however, has been called in question by a geologist of great eminence, Mr. Godwin Austen, who maintains that the human remains and the arrow-heads and knives of flint occur promiscuously with the bones of the extinct animals in all parts of the cave, and through the entire thickness of the clay; and that no distinction, founded on condition, distribution, or relative position, can be established, whereby the human can be separated from the other relics.

"Mr. M'Enery observed that the flint implements found in the lower deposit were rude, compared with those higher up. This is in accordance with what Mr. Worsaae and other antiquaries have remarked, that what has been called the *stone period* requires to be subdivided, and that there are marks of two stages of advancing civilization, discriminated by the different degrees of skill shown in the manufacture of the implements of flint.

"Mr. M'Enery's researches give a truly formidable view of the strength and ferocity of the carnivorous animals to whom Kent's Cavern served as a den or a sepulchere; such as the *Machairodus latidens*, the *Ursus spelæus*, and the Hyæna. Even the large pachydermata, as the *Elephas primigenius* and *Rhinoceros tichorhinus*, whose bones were found here, must have been dangerous contemporaries to man, armed only with flint implements. Whether they were really contemporaries here is rendered doubtful by the conflicting accounts of Mr. M'Enery and Mr. Austen. Scientific inquirers, however, as Professors Owen and Phillips, have expressed themselves in favour of the opinion that man may have been contemporary with some of the now extinct species of mammalia. This can indeed furnish us with no exact measurement of time, but it seems to carry the history of man further back into past ages than our ordinary chronology allows. Geology has shown, that the progressive changes which the globe has undergone, have been a continued preparation for his residence. He could not want the means of subsistence where the ox and the deer could live, and their bones have been found in the Kent Cavern. It seems in accordance with the wisdom and benevolence of his Creator, that the scene thus prepared for him should not wait long for his introduction."

Most reluctantly do we pass over many other instructive communications to this society, by W. Reed, Esq., F.G.S., on "Fossil Fishes of Monte Bolca;" "The Bovey-Tracy Coal;" "Archæological Papers," by the Rev. J. Kenrick;" and two on the "Decay of Building-Stones," by Dr. Proctor; but we must pass on to other useful institutions.

In DEVONSHIRE an association has just been formed for "the Advancement of Science, Art, and Literature." It is supported by several gentlemen of high position and influence, and its meetings are to be held by turns in the various towns of importance in the county. Exeter was the first rendezvous, and the most interesting feature of the first meeting was the visit of the members of the Bovey-Tracy coal-fields, under the guidance of the well-known Devonshire geologist, Mr. Pengelly.

During the Easter recess a somewhat similar exhibition to the one at Northampton, recorded in our April number, took place at Romsey, in Hampshire. It was called an "Exhibition of the Works of Art and Industry," and was honoured with the presence of the Premier and several other noblemen and ladies. The display was chiefly of a local character, but was enriched by contributions from the collections of the nobility and gentry of the neighbourhood, and from the South Kensington Museum.

NATURALISTS' FIELD CLUBS.

THESE excellent societies are gaining increased vitality, and new ones are springing into existence in every nook and corner of Old England; and, as they are capable of thriving wherever a flower blossoms, or wherever the earth's crust is laid bare to human vision, requiring neither rich patrons, large income, nor magnificent halls of assembly, but only God's pure air and green fields as meeting-places, we have no doubt that each succeeding season will see them multiply in numbers and importance.

At WIGAN, in the midst of smoke and grime, but in the centre also of a rich geological field, such a society has just been formed, and was recently inaugurated with some *éclat.*

The demonstration itself was of an interesting character. Collections of objects of natural history, magnificent microscopes, interesting microscopical objects, aquaria, fern-cases, geological collections; with speeches, singing, instrumental music, and refreshments, were the attractions which ushered into existence what, we have no doubt, will be a successful and agreeable society.

A circular, bearing the signature of several leading men of intelligence, in CLIFTON, was issued in March last, to the inhabitants of Bristol and the neighbourhood, calling upon them to form a Field Club, after the model of those at "Worcester, Malvern, Liverpool, and other large towns," and to "restore to Bristol the prestige it once possessed" for the successful cultivation of natural history. The programme contains every element of success: a low subscription, short excursions, the publication of transactions, &c. &c., and, *we hope,* although it is not mentioned, the admission, nay, every encouragement for the attendance of ladies. We trust the good people of Bristol have responded to the call, and shall now take a run over to TEIGNMOUTH, where there is a small but successful Field Club, which entertained the Archæological Association in 1861. The "proceedings" of this club show that the delightful combes and coves of Devonshire are not neglected by naturalists and geologists; and we find that Mr. Pengelly is an active member of the society, and often imparts a deep interest to its meetings by his instructive addresses on the geology of the district.

The MANCHESTER FIELD-NATURALISTS' SOCIETY continues to flourish, under the active secretaryship of Mr. Grindon; and, to quote the last Report, "the year 1861 has been a period of unbroken prosperity. Everything has gone well, and the prospects for the future are altogether satisfactory."

On the 12th February, the society numbered 430 members, of whom 103 were ladies. Fourteen excursions were made into the surrounding country during the season; and here, as at Liverpool, we find that the ladies are amongst the most successful collectors of plants. Prizes are offered for the best herbaria and cabinets of insects, and photographic views are taken of the places visited.

The soirées, we are told, have been even more successful than the excursions, and the "club" is extending its influence into every circle of society. The Report says, with great truth,—

> "It is not to be expected that the Field-Naturalists' Society, or any similar society, can ever make a great display before the public of what they have accomplished in the shape of work. It is sufficient to find that scientific tastes and philosophical habits of thought are developed, and have had a practical turn given to them, and that members take up different branches of natural history, and apply themselves to sedulous private study, known only to their private friends. This is largely the case in the Field-Naturalists' Society. It is difficult now to go into intelligent company in Manchester, and not find some person who is either a member of the Society, or has attended one of their soirées or excursions as a visitor, and who is glad to acknowledge the pleasure experienced there, and the encouragement he has received to personal inquiry and observation. The amount of latent scientific taste in Manchester is far greater than many would conceive possible, and the Field-Naturalists' function and pleasure is to draw it out and give it direction."

The Liverpool Field Club also continues to extend its numbers and influence. At the close of the season of 1861 it had 630 members, of whom 184 were ladies. At each meeting during the present season many new members have joined. The ladies are the life and soul of this society, and, in order to hold out additional inducements to them to join its excursions, the committee have added to the prizes already granted for the largest number of species collected, another, which is accorded to the lady who gathers and arranges the best bouquet of wild flowers. The "bouquet prize" is an object of great competition amongst the fair ones of Liverpool. We may mention, for the guidance of the directors of other similar societies, that these prizes are well calculated to maintain the interest of the members in the excursions, not so much on account of the value of the books, as the honour which the prizes confer on the successful candidates. The greatest number of species of plants collected during the season was 124, by Mrs. Gibson, and the numbers on other occasions varied from 67 upwards. Miss Rowe, a young lady member of this club, is remarkably successful in these competitions, and possesses very extensive knowledge in systematic botany.

The Holmesdale Natural History Club (Surrey) are publishing a "Flora of the County of Surrey," concerning which we are informed by circular that,—

> "The Flora will be arranged on the natural system, and the nomenclature and classification will correspond, as far as practicable, with those of the fifth edition of the 'London Catalogue of British Plants,' on which the manuscripts of Mr. Salmon are based."*

In our last number but one (April), we had occasion to refer to the operations of the WARWICKSHIRE NATURALISTS' FIELD CLUB, and since then we have received a report of its proceedings.

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* The publication originates in a collection of plants formed by the late J. D. Salmon, Esq.; and if any of our readers should require copies of the work, they may have them by applying to Mr. J. A. Brewer, Holmesdale House, Reigate. The price to subscribers is 7*s*. 6*d*.

These contain a very eloquent address by the president, C. W. Hoskyns, Esq., which our limited space will unfortunately not allow us to transfer to these pages, or we should have transcribed it verbatim, for we are not exaggerating when we say that Mr. Hoskyns' remarks should be read by all who are interested in the successful working of these societies. He referred to the advantages of the study of Nature in her own domains over the perusal of books only; denied the existence of a line of demarcation between the "intellectual" and the "moral;" "terms of our manufacture," as he calls them, and showed how closely they are interlinked with each other. He demonstrated the practical value of scientific research, and instructed the members of the society, over which he presides, how they might best carry out the important objects for which they meet together.

After the president's address, a carefully prepared lecture, on the "Geology of South Northamptonshire," was delivered by the Rev. P. B. Brodie, V.P. Others followed, on various subjects of interest.

On the 27th June, the Warwickshire club visited Malvern, and, fraternizing with the club there, inspected the objects of interest in the neighbourhood; such as the railway tunnels, which present many features of geological interest, the Malvern hills, &c.

In concluding these remarks upon our Field Clubs, we have to recommend more frequent meetings between neighbouring societies, from which much good cannot fail to be derived. A comparison of their respective experiences will be mutually beneficial, and will no doubt frequently lead to the dissemination of scientific truths, the knowledge of which would otherwise have been confined to a few members of one club; and such meetings, too, are conducive to the social and moral welfare of society, inasmuch as they bring into closer relations the most intelligent members of various communities, and remove prejudices and asperities. To those amongst our readers who have been in the habit of regarding science as a dry and laborious pursuit, fit only for bookworms and visionaries, we say, "Join a Naturalists' Field Club, and attend its excursions."

REVIEWS.

PEAKS, PASSES, AND GLACIERS.*

IT may seem rather late now to ask what was the original object of the "Alpine Club," beyond that of meeting in friendly symposium to compare notes and experiences of pleasant long-vacation trips over a dinner-table, and decide what new worlds among the Alps yet remained to conquer. Two series of narratives, nearly fifty in number, written by thirty-nine adventurers in the lofty mountains, have been put before the public, and, as far as the publishers are concerned, it may be presumed not without success. Still the exact object and the result are not clear. How many peaks, before thought inaccessible, have been climbed, and the history of the trip recorded in imperishable type? How many difficult passes have been discovered and crossed? and, perhaps, most of all, how many glaciers, or how many hundreds of miles of glacier, have been traversed that would otherwise have long remained undisturbed except by the rolling of avalanches? All these are points that may be calculated; but, certainly, the literary or scientific fruit is small and unripe. At any rate, the fashion of *doing mountains* is on the increase, and the Alpine Club must have contributed to the growing taste. It is in the hope that the explorations of future adventurers may take a more scientific turn that we give these a place here. Meanwhile they must be dealt with as we find them.

Except an account of a tour in Iceland—a country very little visited by the tourist and not offering much inducement for a visit to any but determined travellers—there is little in the volumes before us that has much of absolute novelty to recommend it.

An interesting notice of a Pyrenean ascent from the Bagnères de Luchon proves that adventure is not entirely confined to the Swiss, French, and Italian Alps, among the European mountains; but as so very large a proportion of the members of the Club seem to decide on attacking that chain again and again, rather than attempt any new field of operations, it must be assumed that there yet remains much to be done there; and, perhaps, we may look forward in time to a considerable library of illustrated stories of Alpine travel.

It is evident that the writers of narratives which in themselves are so much alike that the description tends to become monotonous feel that they must adopt varieties of style to cover a want of variety of matter. Thus,

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* *Peaks, Passes, and Glaciers. Being Excursions by Members of the Alpine Club.* 2nd Series. Edited by EDWARD SHIRLEY KENNEDY, A., F.R.G.S., President of the Club. 2 vols., 8vo. London, 1862.

Mr. Ormsby, in giving an idea of his ascent of the Grivola, a somewhat dangerous and difficult mountain, entirely disclaims the smallest object, whether scientific or other, beyond the mere gratification of a whim. In his narrative, also, he exhibits great indifference to the ordinary forms of language; and equal love of, and a familiarity with, slang, both in words and style. As a background of relief to a flat picture this may be a sad necessity; but it is to be hoped that in future volumes the pictures may not require this mode of heightening their effect.

Among the more interesting of the groups of travels in the two volumes before us are those which introduce the mountains of Dauphiné to the reader. But these mountains have all been visited, and the most important facts concerning them have been stated by Professor J. Forbes. Elie de Beaumont, also, has done important work in the district. No doubt there is still much left for the explorer to do, and the district seems well fitted as a scene of trial for the tyro in Alpine work. Another interesting group of mountains recently explored is the group of the Graian Alps and the Mont Iseran, which latter is declared to be a mule-track, and not a mountain.

It is impossible, in the course of a few pages, to give any readable notice of the large number of separate narratives collected in these two volumes. Many of them are uninteresting, and most of them are wanting in telling description. We started at daybreak—we traversed snow and ice, rock and water—we climbed here—we slid down there—we had our luncheon and enjoyed our champagne—our guide did know his way—we ran great risk, but at last we reached the point to which we were bound, and, then—why, then, we got back again, had a good supper, and slept the sleep that the just are reported to enjoy, but that men thoroughly exhausted, whether just or unjust, are almost sure to fall into. Such, with a few details of heights and distances, an occasional correction of what the last describer did and said, a little self-glorification, and much praise of faithful guides, is, in a few words, the sum and substance of all these narratives.

And yet, no doubt, any one such narrative, if read by itself and if written naturally, without a manifest intention to astonish and delight the reader, would be very pleasant and very suggestive, especially to those who have themselves travelled, and have visited more or less of the scenes described. Such an account is that of Mr. Forster, who crossed from the Grütli to the Grimsel, by that most charming of all Swiss valleys, the Valley of Engelberg. We will endeavour to give our readers who have not crossed from the head of the Lake Lucerne to the Uri Alps some idea of what awaits them, if they will undertake the labour and risk incident to this piece of mountain travel. It is a work not beyond the powers of any hardy, healthy man, and will amply repay the exertion.

To Lucerne by rail, and to the "Grütli" or "Meadow" by steamer, is an affair of hours easily measured and easily performed. The Grütli is, in fact, that meadow, dear to the imagination of all Swiss patriots, where the three great founders of Swiss liberty met to swear that they would rescue their native land from foreign thraldrom. It has recently been purchased by subscription and laid out under the auspices of Government. It is certainly one of the most romantic spots in the wildest and finest part of the lake of the four cantons. Landing, and running up to the Sonnenberg, where is a delightful "pension," Mr. Forster, who started on his journey in bad health, found means, in a few days, so far to recruit that he determined to set out on an expedition, which we will now briefly abstract. The Sonnenberg, by the way, is strongly recommended as an easy and extremely accessible retreat from the great herd of travellers, and, situated as it is on the promontory of high land forming the last of the great recesses of the Lake of Lucerne, the situation is in every respect admirable.

From Sonnenberg to Isenthal is a pleasant walk, and Isenthal is also a pleasant place—small, clean, and not over-civilized or over-frequented. At Isenthal the work begins, and Mr. Forster selected the more difficult of the two routes to the Uri-Rothstock, a very grand peak, which forms a prominent object in most of the views of the Lake of Lucerne. It took six hours from Isenthal, and was rewarded, not only by a grand view of the country, but by the sight of a flock of fourteen chamois, which passed close to the party—a very rare sight, nowadays, under any circumstances, in Switzerland, and one that did not last long. In fact, when the leader of the four-footed party discovered his natural enemy, our author calculates that they went off at the rate of more than twenty miles an hour. The near view from the Uri-Rothstock is preferred by Mr. Forster to that of Titlis,' the glacier and *névé* extending to the next peak, the Engelberger Rothstock (*red stick*—the cones are of pinkish limestone). There are, however, no extraordinary difficulties, and Mr. Forster proceeded alone from this point to the valley of Engelberg. The field of snow traversed requires two hours to cross.

There are few more delightful spots in Switzerland than the valley of Engelberg; and at the establishment there, the Hôtel de l'Ange, every reasonable comfort is obtained at most reasonable prices. It is large and well provided, and there is a good road to it from the lower part of the Lake of Lucerne opposite Pilatus. From it, also, numerous excursions may be made, and some of the grandest scenery is very approachable. Titlis raises his head immediately adjacent. The Surenen pass is close at hand, by which, if preferred, either Altdorf or Sonnenberg may be reached. The Joch conducts across to Meyringen; and, for those who are more adventurous, there is a pass on the other side of Titlis across a vast field of ice into the Gadmen Thal. Thence the member of the Alpine Club, disdaining accustomed routes, finds a way across a large, very remarkable, and interesting field of ice—the Trift—pass to the Grimsel.

While on the Surenen Egg, accompanying some friends who were on their way to Altdorf, our adventurer experienced one of those grand, though not very rare, meteorological phenomena—a thunderstorm. The storm passed beneath his feet—rushing up, borne upon the fierce south-west wind at a fearful pace, to meet a mass of rain-cloud coming down from the Weiss-stock. Alone on the mountain ridge, exposed to the pitiless beating of hailstones coming down like rifle-bullets, our traveller wisely waited, under shelter of some stones fallen from the rock above, till the violence of the storm had passed.

From Engelberg across the Joch pass is as beautiful and pleasing a specimen of Alpine work as can be imagined. Too common, and offering too little difficulty to demand a chapter in the volume of Alpine travel, it is better worth the trouble it costs than many greater works. There are the most charming Alpine plants growing out of the snow in the exquisite little Trüb See; there are the steep paths and awkward zigzags of the ascent, and the chalets with milk and cheese--the reward of Alpine labour. But these are but the portals to the path of honour to him who would traverse the Trift. The Stein glacier, at the head of the Gadmen Thal, is the beginning of this pass. From this to the Thierberg, a virgin peak, not much more than 11,000 feet high, but not overlooked, was an easy excursion for Mr. Forster. Afterwards, descending to the valley, the crossing the Trift was another hard day's work, to reach the well-known glacier of the Rhone—one of the noblest and grandest of all those to be seen in Switzerland. Fifteen hours' hard walking across the ice and rock, but chiefly the former, was required to complete the trip; and Mr. Forster relates, with laudable satisfaction, that he was honoured that night above other guests when it was known that he had accomplished the feat of the Trift, and that, to crown all, he had the satisfaction of being pointed out to some curious lady-travellers, in a mysterious whisper, as the hero of the day—"*Das ist der Forster!*"

We have endeavoured rather to give the reader an idea of the style of the better kind of Alpine narratives than to quote mere detail of places and names. We think it somewhat to be regretted that all the devotion of the traveller should be paid to one chain of mountains, though that is no doubt the loftiest European chain; and we should welcome as a novelty an account of a visit to those glorious valleys and mountains of the Carpathians, that have been little examined hitherto; and a notice of an exploration of the Caucasus, of the mountains of Arabia, or of the greater Atlas. All these are "fresh fields and pastures new."

OUR NEW IRONSIDES.*

WAR, in its materials, its instruments, and its results, is absorbing a large share of attention, even from those least interested in its political bearings. It has enlisted in its service our engineers, and men of science, hitherto occupied in more peaceful achievements, and has required of them the solution of some of its most difficult problems. And whilst we wait in the expectation of a time when the need of warfare shall no longer exist, when appeal to arms shall be suppressed in public, as it has already been in private disputes,—whilst we hope that, in the end, each man will "find his own in all men's good," and the mailed fleets and armed towers be broken,—it is yet wisest to learn sadly, from the events of our time, that the ancient scourge of national weakness may not be laid aside; that the last resort in national differences is still the arbitrement of the sword. And hence we are content to see, in the midst of the peaceful gathering of the works of our industry and our art, the most perfect finish, the most subtle invention, and the utmost resources of our mechanical skill expended on the " works of war."

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* *On the Properties of Iron, and its Resistance to Projectiles at High Velocities.* By WILLIAM FAIRBAIRN, Esq., D.C.L., F.R.S.

How to arm our navy to resist the heavy projectiles of modern artillery, and, above all, how to keep out those frightful instruments of destruction, the explosive and molten iron shells, is a problem involving conditions so novel that, during the past year, it has raised more discussion amongst engineers than any other. In the pamphlet before us, Mr. Fairbairn contributes the results of his experience and research, as to the qualities of iron, and the mode of its application best adapted for the protection of ships of war. He long since expressed the opinion that the material, which has almost superseded wood in the mercantile marine, would ultimately prove most suitable for the navy; and this, notwithstanding the adverse results of the partial experiments in 1827, and subsequently. He has lived to see his opinion universally shared, and satisfactorily established in actual warfare, at Kinburn in 1855, and more recently in America. In the new conditions in which we are thus placed, by the improvement of artillery on the one hand, and by the adoption, by other nations, of iron armour for purposes of defence, after satisfactory proof of its superiority to wood,—

> "We must look," says Mr. Fairbairn, "to new materials, and an entirely new construction, if we are to retain our superiority as mistress of the seas. There yet remain amongst us those who contend for wooden walls, but they are no longer applicable to the wants of the State; and I am clearly of opinion, that we cannot afford to trifle with so important a branch of the public service as to fall behind any nation, however powerful and efficient they may be, in naval construction."

He adds, that a revolution is in progress in the destiny of the navy, and then continues :—

> " It is not for us alone that cyclopean monsters are now issuing from the furnaces of Vulcan; and it behoves all those exposed to such merciless enemies to be upon their guard, and to have their *Warriors*, *Merrimacs*, and *Monitors* ever ready, clothed in mail from stem to stern, to encounter such formidable foes. It has been seen, and every experiment exemplifies the fact, that the iron ship, with its coat of armour, is a totally different construction to the wooden walls which for centuries have been the pride and glory of the country. Three-deckers, like the *Victory* and the *Ville de Paris* of the last century, would not exist an hour against the sea-monsters now coming into use. The days of our wooden walls are therefore gone; and, instead of the gallant bearing of a 100-gun ship, with every inch of canvas set, dashing the spray from her bows, and careering merrily across the ocean, we shall find in its place a black demon, some five or six hundred feet long, with a black funnel and flagstaff, stealing along on her mission of destruction, seen above water sufficiently only to exhibit a row of teeth, one on each side, as formidable as the immense iron carcase floating below. This may, with our present impressions, be considered a perspective of the future navy of England; probably not encouraging, but one on which the security of the country may ultimately have to depend, and to the construction of which the whole power and skill of the nation should be directed."

In reading this description of the unromantic attributes of a modern mail-clad vessel, some of our readers will probably deplore the entire disappearance of the poetry, hitherto associated with the navy, and may perhaps be reminded of Byron's lines:—

> "She walks the waters like a thing of life,
> And seems to dare the elements to strife.
> Who would not brave the battle fire,—the wreck,
> To move the monarch of her peopled deck!"

and then turn somewhat deprecatingly to that most graphic account of the *Monitor* as "a Yankee cheese-box on a raft," which is said to give a better idea of her appearance than any of the engravings which have been published. In our own armour-clad vessels, the æsthetic element has not hitherto been sacrificed to so great an extent; but Captain Coles's cupola ships which are in progress will closely accord with the American type.

The questions dealt with in the pamphlet relate to the quality of iron most suitable for armour-plates, and the laws of resistance of such plates to projectiles, as determining the conditions under which they should be applied in naval construction.

Of the three materials, cast iron, wrought iron, and steel, the first is manifestly defective in all the qualities requisite; but the choice between the other two is more difficult. Tenacity, or cohesive force and toughness, or capability of yielding to a blow without fracture, are pointed out as the qualities most desirable. The tenacity of steel is twice as great as that of wrought iron; but Mr. Fairbairn implies that in the trials with ordnance it has proved inferior, even when so soft as to contain only 0·25 per cent. of carbon. If this be the case, our French rivals have made a mistake in clothing *La Gloire* with steel-faced plates.

It is interesting to remark, that chemistry has aided the engineer in this inquiry, the absence of carbon being one of the most available indications of the value of an armour-plate. The data which Mr. Fairbairn quotes show also that the most minute excess in the proportions of sulphur, phosphorus, and silicon, in Dr. Percy's analyses, correspond exactly with deteriorations of strength in his own experiments on the same plates, and with inferiority in resistance to projectiles in the trials at Shoeburyness. The purer the iron, therefore, the greater its value for defence. This result might have been anticipated, but it is none the less interesting to find it clearly demonstrated in independent researches.

In defensive constructions the engineer has to comply with entirely new laws of resistance. Hitherto he has almost universally dealt with slowly-applied forces, which it was convenient to regard as dead (or statical) pressure. But projectiles have a velocity of 1,100 to 2,000 feet per second, and inflict an injury wholly incommensurable with the statical resistance of the plates. Statical forces acting for an indefinite period are regulated by one law; sudden and almost instantaneous impact, by an entirely different one. It is in consequence of a misconception on this point that much of the discrepancy of opinion on the subject of iron armour has arisen. And an adequate return will have been made to engineers for the service they have rendered to naval construction if it induces them to pay more attention to the dynamic resistance of materials. It will lead to the explanation of many catastrophes (boiler explosions and the fracture of the Hartley Colliery beam, for example) which have been considered almost inexplicable. And war will thus have nourished the arts anew, and yielded fruits of peace.

Mr. Fairbairn shows that the destructive power of the shot depends on its *vis viva*, or the work accumulated in it during the explosion of the powder, and which is known to vary as the product of the weight of the shot and the square of the velocity generated. This product is in turn known to vary as the weight of powder in the charge. The shot is, therefore, merely a carrier of the energy disengaged by the chemical decomposition of the powder. That the destructive power of the shot increases with the square of the velocity explains the inefficiency of the American 200-pounder "Parrot guns," in which only small charges of powder can be expended as compared with the guns employed in the experiments in this country. It also explains the enormous power of the 300-pounder smooth-bore at Shoeburyness when firing a 150-pounder ball with a charge of 50 lb. of powder. Of this last Mr. Fairbairn says :—

> "We had just arrived at the desired point of security when the thundering 300-pounder, smooth bore, upset our calculations and levelled the whole fabric with the ground."

The velocity of the 150 lb. shot probably approached 2,000 feet per second.

On the vexed subject of "ships *versus* forts" Mr. Fairbairn sides with Lord Palmerston. He says :—

> "A great outcry has been raised about the inutility of forts ; and the Government, in compliance with the general wish, has suspended those at Spithead ; I think improperly so, as the recent experiments clearly demonstrate that no vessel, however well protected by armour-plates, could resist the effects of such powerful artillery" (as the 300-pounder alluded to above).

Whether the doubt, expressed in the last paragraph, as to the possibility of obtaining invulnerability in ships is well founded must be determined by further experiments ; but, looking to the law enunciated by Mr. Fairbairn, that the resistance of plates increases as the square of the thickness, it would appear that at present our means of defence in ships are in advance of the artillery which can be brought to bear against them. The enormous 300-pounder only just penetrated the target representing a section of the *Warrior* and protected by 4½-inch plates, and that, too, after it had been struck by 3,229 lb. weight of metal. But 5 and 5½ inch plates are being employed, which will increase the resisting power by 25 and 50 per cent. respectively, and it is doubtful whether these would be penetrated by even the most powerful modern artillery, at least with the present cast-iron service-shot. In America, 10½-inch plates have been used, but there is, no doubt, a limit to the thickness to which the law of the squares applies. Very thick plates of wrought-iron have been found to break brittle like plates of steel, either from a deterioration in the quality of the material or from the rigidity of a thick mass, causing fracture according to a different law. The entire invulnerability of the

American iron-cased vessels in actual warfare, imperfectly as they are constructed when compared with the *Warrior* or *Black Prince*, is very remarkable. Whilst, on the other hand, the terrible effect of shells on the wooden *Cumberland*, in the battle of Hampton Roads, which, in a short half hour, made her interior look like "a burnt and sacked house" and sent her blazing to her ruin, may teach us that, whether absolute invulnerability is attainable or not, it is a prime necessity of modern warfare, and a guarantee for peace, to provide such security as iron will afford against these new missiles.

A Glossary of Mineralogy. By Henry William Bristow, F.G.S. Longman. London. 1862.

MINERALOGY is a science that has few votaries in England, but a certain knowledge of it is indispensable to the chemist and geologist; and to these the book lately published by Mr. Bristow will be found extremely useful, if not indispensable, for reference.

Mr. Bristow does not confine himself to a mere alphabetical descriptive list. In a short introduction he notices the various properties of minerals and the modes of determining them. Like other geologists who have to use this science as an adjunct, he leans to a chemical arrangement, quoting the method followed by Professor Warrington Smyth at the Museum of Economic Geology, which in all essential features resembles that adopted by Professor Ansted in his Elementary Course of Geology and Mineralogy. He introduces a very large number of synonyms; and the accounts of the principal minerals are pithy, definite, and comprehensive. Remarkable specimens in the public museums of England are referred to, and localities are not neglected. The composition is quoted either by chemical symbols or as a distinct analysis.

In the present state of mineralogical science—and it is not likely soon to improve—there is a great advantage in the alphabetical arrangement, as those who have consulted the works of Dana and even of Phillips, in its most approved form, will generally admit; and we doubt not that Mr. Bristow's book will be useful. We would suggest, however, that in a future edition he should give a few more cross references, and bring down his list of localities to accord with recent discoveries. It is rather puzzling to have to think under what heading sulphur, silver, and copper are to be sought, and not easy to see why gold should be described under its own name and the other minerals we have mentioned as *natives*. We miss, too, names so common as *Kaolin*, finding *Pe-tun-tse* and *Kunkur*, which are much less defined varieties. We miss also *Lederolite* (a variety of *Chabasite*); *Marmatite* (a variety of *Blende*), and a few others. These are pointed out rather to show that a careful revision is desirable, than as finding fault with a task which, on the whole, is very well accomplished.

On the various Contrivances by which British and Foreign Orchids are Fertilized by Insects, &c. By Chas. Darwin, M.A. (Illustrated.) Murray.

THE perusal of Mr. Darwin's book on "The various Contrivances by which British and Foreign Orchids are fertilized by Insects," might incline the reader to regard it as the result of nothing less than a life devoted exclusively to the subject. Yet of the great discussion concerning the "origin of species," the present work is, in fact, only a single chapter, the details of which have become inconveniently large to be incorporated with the rest of the argument.

The point which the author here seeks to establish is thus stated. "That nature abhors perpetual self-fertilization." "That marriage between near relations is in some way injurious—and that some unknown great good is derived from the union of individuals which have been kept distinct for many generations."

Self-fertilization is a rare event with the Orchids, and the description of the various contrivances by which the pollen of one plant is kept from contact with its own stigma and conveyed to that of another plant of the same species, occupies nearly the whole of the volume.

Orchids, it appears, are favourite plants with honey-loving insects. When the proboscis of a bee or a moth is inserted into the nectary of an orchid, it first comes in contact with a little capsule or pouch, the membrane of which at the slightest touch is ruptured, setting free a liquid and exposing the sticky ends of two club-shaped organs, to the further ends of which the pollen grains are attached. The sticky ends instantly adhere to the proboscis, which, when retracted, carries with it the pollen clubs fastened upon it in a somewhat erect position. Further down the throat of the nectary lies the stigma.

We have then to observe (first), the retired position of the anther chambers, of which there are two, containing the charged ends of the pollen clubs. (Second.) The prominent position of the viscid ends of the pollen-clubs in the throat of the nectary. (Third.) The manner in which the sticky ends of the pollen-clubs are kept moist, till wanted for use, by being immersed in a little pouch of liquid. (Fourth.) The extreme sensitiveness of the lips of this pouch, which open at the slightest touch imaginable. (Fifth.) The rapid setting of the viscid matter, which hardens into a dry cement in a very short time after the sticky ends of the pollen-clubs have touched the proboscis of an insect. (Sixth.) If the attached clubs remained erect, the proboscis at its next insertion into a flower would press the pollen grains into a position similar to that from which they had been taken, namely, into the anther chambers; but no sooner are the clubs fast than their pedicels uniformly begin to curl forward, bringing the pollenized ends of the clubs almost close to the proboscis in a more forward position, so that when the next flower is visited the proboscis pushes the pollenized tips of the clubs past the anther chambers and right upon the stigma of the flower.

In the genus *Catasetum* the flower has two slender horns, which when touched by an insect convey the excitement of the touch to the anther chambers, which instantly discharge the adhesive pollen-clubs at the head of the intruder. Thus, and thus alone, at least three species of the genus *Catasetum* are fertilized.

Mr. Darwin has manifestly spared no labour in collecting facts illustrative of his subject. He gives a list of twenty-three species of Lepidoptera captured with the pollen-clubs of *O. pyramidalis* attached to their probosces. He has himself made observations on nearly all the British species of orchids, and upon a large number of exotic species, and he arrives at the conclusion that, "throughout the vast Orchidean order—including, according to Lindley, 433 genera, and probably about 6,000 species—the act of fertilization is almost invariably left to insects."

The chapter on the homologies of Orchids is one of the most interesting portions of the book.

At Torquay, Mr. Darwin watched a number of plants of *Spiranthes autumnalis*, and saw them visited by humble-bees. "The bees always alighted at the bottom of the spike, and, crawling spirally up it, sucked one flower after another." "I believe humble-bees generally act thus when visiting a dense spike of flowers, as it is most convenient for them; in the same manner as a woodpecker always climbs up a tree in search of insects." This seems a most insignificant observation; but see the result. In the early morning, when the bee starts on her rounds, let us suppose that she alighted on the summit of a spike, she would surely extract pollinia (pollen-clubs) from the uppermost and last opened flowers, but when visiting the next succeeding flower, of which the labellum in all probability would not as yet have moved from the column, for this is slowly and very gradually effected, the pollen masses would often be brushed off her proboscis and be wasted. But nature suffers no such waste. The bee goes first to the lowest flower, and crawling spirally up the spike, effects nothing on the first which she visits till she reaches the upper flowers, then she withdraws the pollinia; she soon flies to another plant, and alighting on the lowest and oldest flower, into which there will be a wide passage from the greater reflection of the labellum, the pollinia will strike the protuberant stigma. If the stigma of the lowest flower has already been fully fertilized, little or no pollen will be left on its dried surface; but on the next succeeding flower, of which the stigma is viscid, large sheets of pollen will be left. Then, as soon as the bee arrives near the summit of the spike, she will again withdraw fresh pollinia, will fly to the lower flowers on another plant, and fertilize them; and thus as she goes her rounds and adds to her store of honey, she will continually fertilize fresh flowers, and perpetuate the race of our autumnal Spiranthes, which will yield honey to future generations of bees.

SCIENTIFIC SUMMARY.

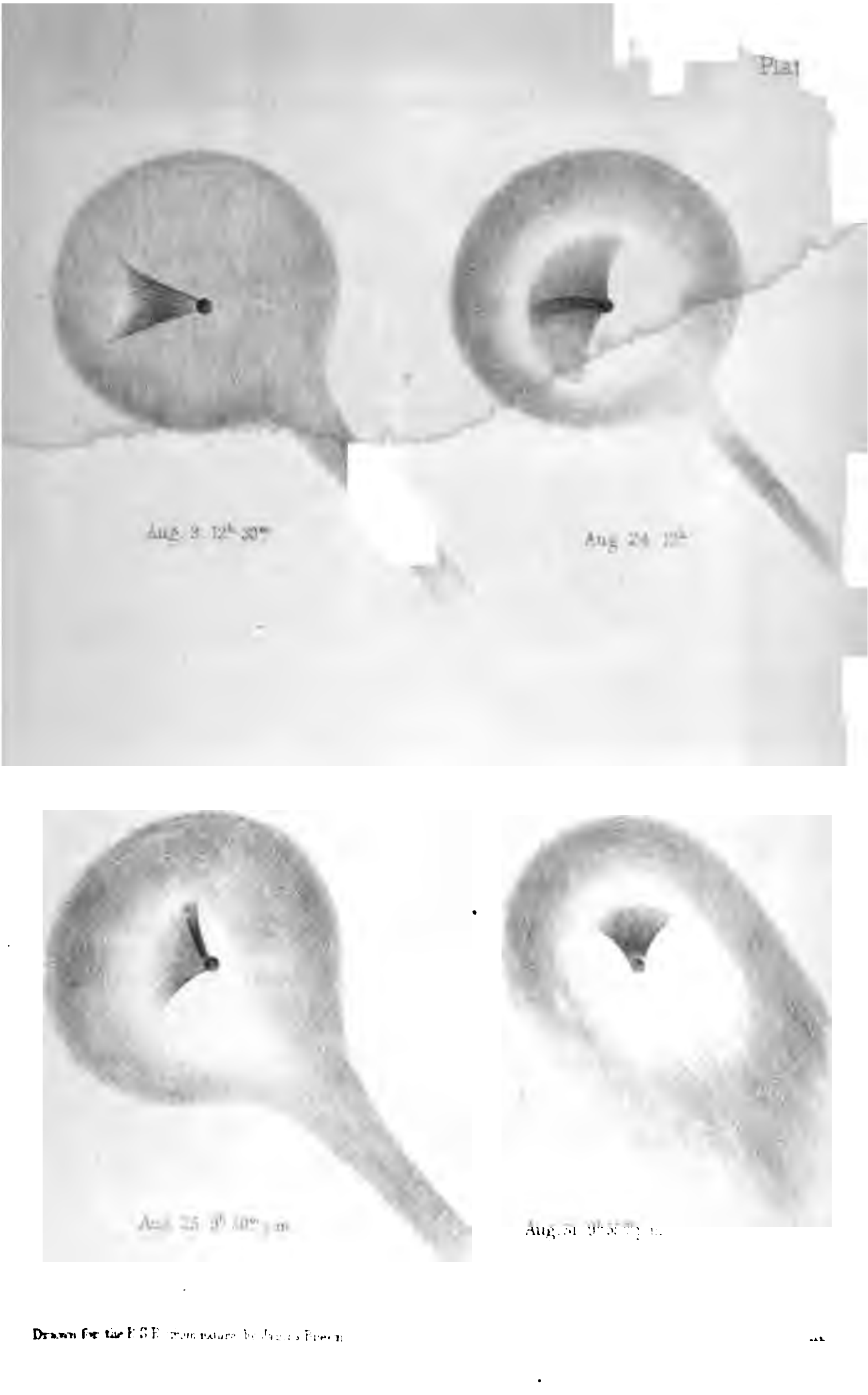
QUARTERLY RETROSPECT.

ASTRONOMY.

A SMALL telescopic comet was discovered by Schwabe, at Athens, on July 2, and, a few hours later, at Marseilles, by Mr. Tempel. Subsequent observations and calculations proved that it passed its perihelion on June 22. It continued all along very faint, and was only visible in good telescopes. Its least distance from the sun was about ninety-five millions of miles—almost identical with the earth's mean distance from the central body. We have not seen it noticed that the orbit of this comet bears some resemblance to one discovered at Paris, on September 2, 1698. The direction of motion, the inclination to the ecliptic and the longitudes of the perihelion and node agree pretty well, and the least distance from the sun is not very dissimilar. The comet of 1698 is, however, stated to have been as bright as a star of the second or third magnitude.

A second and much brighter comet was discovered on July 18, at midnight, at the Cambridge (United States) Observatory, in the constellation of Camelopardalus. It was independently detected at Florence, on July 24, and, on the following night, at Rome, by Professor Rosa. On the latter day it is described as being round, with a nebulosity of from three to four minutes in diameter and a distinct nucleus. Although almost circular, it was slightly dilated in the direction of the sun. No tail was visible in the comet-seeker, although with the naked eye one was faintly perceptible. On August 3, when first seen by the writer, the comet was plainly visible to unassisted vision, and a slender tail was distinctly seen in the finder of the telescope. The nucleus was bright, and a well-defined fan-light was seen proceeding from one of the sides, which was almost at angles with the tail. On August 19 the comet had become a very conspicuous object in the Northern hemisphere and the tail could be traced with the naked eye for a distance of eight or ten degrees from the head. The luminous sector had, however, disappeared, and an exceedingly bright jet of cometic matter lay in the contrary direction to the tail. At midmight of August 24, the luminous sector again made its appearance, and a faint envelope was suspected as surrounding that part—a bright jet passed across the fantail from the nucleus, lying almost at right angles to the tail, which latter was as slender as on former occasions, and was separated from the head by an almost dark space. On August 25, at

Plat



Aug. 9. 12h 30m

Aug. 24. 12h

Aug. 25. 9h 10m p.m.

Aug. 31 9h 35m p.m.

Drawn for the R.S.E. from nature by James Breen

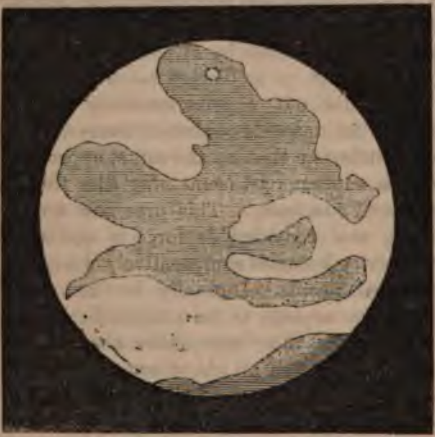
Comet of July and August 1862.

9.30 p.m., the fantail was still faintly visible, but the bright jet of light was now turned in the contrary direction to the tail and appeared like a miniature comet. The aspect of the comet had considerably changed since the preceding evening, and the tail appeared to have become broader and brighter, and to be connected with the head in a more solid manner. No opportunity occurred of viewing the comet before August 31, when a great change was observed to have taken place. The head and tail were now similar in appearance to those of Donati's and the great comet of 1861—the fantail was brighter than on former occasions: the edges being the most brilliant portions; and the tail was now almost as broad as the head, although considerably fainter. Instead of the appearance of a bulbous root attached to a slight stem, it had assumed the ordinary shape of large comets. It will be seen from the foregoing observations and accompanying plate that the position of the fantail, but more particularly that of the luminous jet within it, was constantly varying. The same phenomenon has been noticed in every great comet observed since the invention of the telescope, although it is only of late years that the matter has been thoroughly investigated. Bessel considered that it was a real oscillation to and fro, dependent on the action of the sun. The observations made by M. Chacornac on the present comet seem, however, to show that no oscillation takes place, and that the jets of light are separate and distinct. Having narrowly watched the different phases (on one occasion for upwards of sixteen hours without interruption), he comes to the conclusion that, as the comet approaches near the sun, the nucleus emits a vaporous jet (something like that of steam) in the direction of the central luminary. This preserves a rectilinear form for some time, showing that considerable force is exerted at the time; but this latter subsequently becomes comparatively weakened, and the jet takes the form of a cornucopia. It finally becomes foggy and diffused, and the active emission appears to have altogether ceased, when another ray and fresh jet make their appearance about thirty degrees from the first, which, passing through all the changes previously undergone by that, finally vanishes away in the lapse of about sixteen hours, whilst the original jet again comes into view. It remains to be seen whether this curious discovery will be verified by the whole series of observations; at all events, it will put observers on the watch to follow more narrowly the changes occurring in those (in every respect) erratic and mysterious objects. It may be added that the path described by this comet bears no resemblance to any previously observed. It passed at its shortest distance from the sun on August 23, when its distance from that luminary was about ninety-two millions of miles. It moved in an orbit inclined sixty-six degrees to the ecliptic, and the head, it was reckoned, was about 100,000 miles in diameter.

Two *well-certified* disappearances of nebulæ have been recorded within the last three months. In both cases the original observations have been of recent date, so that there can be no suspicion of mistake. The first is situate at 3h. 21m. of R.A., and + 30° 54′ of Decl. A few years since it was visible in a two-foot comet-seeker. In 1859, February, it was barely visible in a telescope of three-inch aperture; and, in August of the present year, it was scarcely perceptible in the great Copenhagen refractor.

With a telescope of three-fourths the original size nothing was visible. The second variable nebula is situate at 3h. 38m. of R.A., and + 23° 23′ of Decl. In 1859, October 19, Tempel describes it as large and bright, with a two-foot telescope. In December, 1860, it was scarcely visible in a six-foot telescope; whilst, at the present time, it is scarcely visible in the largest instruments. It is to Professor D'Arrest that we are indebted for these startling discoveries, which completely alter all our notions in respect to nebulæ. It is very remarkable that the two new variable nebula are situate within nine and eight degrees from the missing nebulæ of last February. The idea of a cosmical cloud, which has been imagined in order to explain other phenomena, will doubtless be reverted to in the present instance. There are very few nebulæ in this region of the heavens, although many clusters and knots of stars. Among others, we have a double nebula, R.A. 3h. 11m., + 40° 43′; a nebula, R.A. 3h. 20m., Dec. + 36° 45′; a nebulous star, R.A. 3h. 59m., Dec. + 30° 20′; and a single nebula at R.A. 4h. 19m., Dec. + 34° 54′.

It will be some years before Mars is seen to such perfection as at the present time. As it will be the only telescopic object among the planets for the next few months, it will of course be duly looked after. It will be the most brilliant object in the heavens during the months of October, November, and December, and will be visible even for the first three or four months of the year 1863. We give a drawing of its appearance on September 17.



Mars, September 17, 1862, at 11 p.m.
by J. Buckingham, Esq., F.R.A.S.

A striking instance of the unnoticed changes which are constantly going on in the heavens is the case of the star in Ophiuchus, marked (*b*) in catalogues and maps. Although the variations in brilliancy of this object have been very decided, yet it has not been until the last few months that they have been remarked, and duly inquired into. It has been found that this star fluctuates through all grades of brightness between the 6th and 3½ magnitude. It was reckoned of the former lustre in July, 1849, by Argelander, whilst in June, 1862, it had increased to the latter. The name of Argelander is a sufficient guarantee for the correctness of the first observation, whilst that of the latter can be verified at the present time. Doubtless, the future changes in the brilliancy of this object will be a matter of considerable moment. One has only to compare the faintest of the seven stars in the "Plough" with that which is merely visible to the naked eye, to realize the difference between the two objects.

With the great Foucault reflector of the Paris Observatory, M. Chacornac has been able to resolve the annular nebula of Lyra into separate and distinct stars. He describes the appearance of this well-known object as if looking down a funnel. He verifies the measurement of Sirius and its companion as previously given by him.

The present summer has been fruitful in solar spots of considerable size. In the gallery of "philosophical instruments," at the Exhibition, we notice the photographs of Mr. Titterton, of Ely, bearing upon this subject, and more particularly that of August 4 of the present year, where the spot, lying at the margin of the sun, makes a considerable indentation on that part. Another remarkable spot was seen by Mr. Hodgson, on June 8.

The Saturnian phenomena, observed during the absence of the ring, have been sufficiently curious. Mr. Dawes has made many remarkable observations of Saturn and its satellites and ring, but more particularly an immersion of Titan in the shadow of Saturn, on May 25, and a transit of the shadow of Titan across the disc of Saturn on June 2.

BOTANY.

Araucaria Imbricata.—The destruction of two fine specimens of the Chili pine in the Edinburgh Botanic Garden by the frost of December, 1860, has given Professor Balfour the opportunity of making some observations upon the bark of these trees. Removing the leaves and outer bark, quadrilateral markings appear, varying in form according to their height up the stem, each of them having been connected with a leaf, and more distinctly visible when the external bark separated spontaneously. The appearances thus presented show so close a resemblance to the marks upon the fossil stems, called Sigillariæ and Lepidodendron, usually looked upon as allied to ferns and lycopods, that Professor Balfour thinks the subject has been too hastily decided, and that it should at least be re-considered; very properly insisting, that the fossil botanist who decides upon mutilated ancient plants should at least have a good knowledge of those now covering the globe.

Substitute for Paper.—M. Eugène Simon has recently sent from Japan to the Société d'Acclimatation some young trees the bark of which is used by the Japanese for making paper. These belong to the mulberry subdivision of the bread-fruit tribe, and are closely allied to the tree from which the Chinese manufacture what is termed *crape paper*, and termed Broussonetia papyrifera. The Japanese trees are B. kaminoki, of Van Sieboldt; and this bark, when properly prepared, could be imported for half the price of rags into this country. Moreover, it might easily be acclimatised in various parts of Europe, upon stony, calcareous soils. The branches are cut off every two years, placed for half an hour in hot water, which causes the bark to separate; it is then dried, macerated, and bleached several times, and finally boiled in a lye of ashes; then dried, and pounded into a pulp with water, and the pulp made into sheets.

Substitute for Cotton.—Another important article of consumption which has much failed of late has taxed the ingenuity of inventors to find a substitute. The cotton-world is on the tip-toe of expectation from the report that a substitute for cotton has been discovered, which has been submitted to the examination of experienced hands, and pronounced, for colour, length, and fineness, all that can be desired. At present, the material which is thus characterized is not divulged, but the inventor or discoverer asserts that it is capable of being produced in any quantity, and at small expense; that is, as low, or lower, than the average price of American cotton.

Lathyrus Tuberosus.—This vetch, common in France, where it is called the *Lorraine truffle*, and which might easily be cultivated in England, is stated, in the "Phytologist," to possess a tuber with a milky saccharine taste, and a whitish fecula, more palatable than the potato, and infinitely more valuable than the batatas, or sweet potato. The flower is handsome, large, red, and pea-shaped; and it is recommended as worthy of acclimatization in this country.

Botanical Expedition to British Columbia.—The committee of the Oregon Botanical Expedition have resolved to send Mr. Robert Brown to Vancouver's Island, on a scientific mission, with directions to explore British Columbia, and the countries adjacent to the Rocky Mountains, and to transmit seeds and roots of plants to the Oregon Association in London.

CHEMISTRY.

PURE CHEMISTRY.—That chemical "will-o'-th'-wisp," *ozone*, has been further investigated by the indefatigable experimenter, Schönbein. He prepares ozone by dissolving pure manganate of potash in oil of vitriol, and introducing into the green solution pure peroxide of barium, when ozone, mixed with common oxygen, makes its appearance, and may be easily detected by the smell and other tests. Amongst other curious and important facts which the Professor has discovered in these researches is one connected with the generation of nitrite of ammonia. This salt, he finds, is always produced when water evaporates in contact with the atmosphere: the mere passage of the water from the liquid to the gaseous state ozonizing some of the atmospheric oxygen, which in its turn converts some of the nitrogen and aqueous vapour into nitrite of ammonia. This may be shown in a variety of ways: for instance, when a piece of clean linen is moistened with distilled water and allowed to dry in the open air, it will be found to contain nitrite of ammonia. This fact is of great interest in connection with the chemistry of vegetation. It has long been debated where and how plants obtain their nitrogen—whether from the soil or from the atmosphere. Schönbein shows that every pore over the whole surface of a plant, by continually evaporating water into the atmosphere, becomes a generator of nitrite of ammonia—preparing part, if not all, of its nitrogenous food; the same thing likewise happening in the ground on which it stands. Schönbein, therefore, inclines to Liebig's opinion—that no plant wants any artificial supply of ammonia, there being enough offered by natural means.

A curious compound of manganese with oxygen—*permanganic acid*—has been investigated by Terreil. The most remarkable fact connected with this body is its volatility. He prepares this acid by distilling, at a moderately low temperature, a solution of permanganate of potash in pure sulphuric acid. Violet vapours are evolved, which condense to a thick liquid of a greenish-black colour and metallic appearance. It is perhaps the most energetic oxidizing agent known: it instantly sets fire to paper and alcohol, the latter with explosion; and, when placed in contact with a fatty body, it detonates suddenly, with emission of a beautiful white light. A very beautiful effect is produced when a few drops of a solution of sulphite of potash are poured upon permanganic acid: a vivid disengagement of light is produced, and a large quantity of acid is carried off in the form of violet vapours, which are reduced in the air and fall down in the shape of brown flocks.

Wanklyn and Carius have prepared a *compound of hydrogen and iron.* By allowing iodide of iron to react on zinc-ethyl, several gases are evolved, and a residue of hydride of iron is left in the tube: it is a black powder resembling metallic iron, and gives off pure hydrogen when gently heated. When dry, it may be kept unchanged; but if moistened with water, it gives off hydrogen and becomes converted into oxide of iron. Hydrochloric acid decomposes it in a similar manner, forming chloride of iron—hydrogen being evolved at once from the acid and the hydride.

Further information on *Thallium,* the new metal, whose existence was first detected by spectrum analysis, has been published by the discoverer, Crookes. It is a heavy metal, bearing a remarkable resemblance to lead in its physical properties. Its specific gravity is about twelve. It has a brilliant metallic lustre, but tarnishes very readily. It is very soft, and may be easily cut with a knife or scratched with the nail; it may also be hammered out and drawn into wire; it fuses below redness, and several pieces may with care be melted together and cast into one lump. The metal is not sensibly volatile below a red heat; its atomic weight is very high. Thallium is readily soluble in nitric acid, and forms well-defined crystalline compounds with oxygen, chlorine, and various acids. The most characteristic property of the new element is, however, the magnificent green colour which it communicates to a flame: this light is perfectly homogeneous and gives a spectrum consisting of only one green line. Thallium, therefore, produces *the simplest spectrum of any known element.* The line appears to be identical in refrangibility with a well-defined line in the barium spectrum. Guided by this delicate test, the discoverer has found that thallium is by no means a sparingly-diffused metal—several pyrites from different parts of the world contain it; and in a paper which the author read before the Royal Society last session he pointed out several sources and localities from which thallium might be obtained by the hundredweight at a time.

Morren has examined the phenomena of *phosphorescence* when the induction spark is passed through rarefied gases. No simple or compound gas singly presents the phenomenon of phosphorescence; but when a mixture of sulphurous acid and atmospheric air is placed in a tube, and the induction spark passed through the rarefied mixture, a splendid and permanent phosphorescence is produced. The cause of this is now shown to be the successive decomposition and recomposition of a singular body well known to chemists, the compound which anhydrous sulphuric acid forms with nitrous acid. When in the state of vapour, and very rarefied, the spark separates it into its two constituents, nitrous acid and sulphuric acid, which have only feeble affinities for each other. When the electricity ceases to pass, the elements cannot coexist in the vapourous state without recombining, especially in the presence of oxygen ; and it is during these molecular evolutions that the phosphorescence is kept up.

The action of the voltaic pile upon different substances in the state of igneous fusion has been examined by M. Giradin, in the laboratory of the Duc de Luynes. Passing over the results obtained with salts of potash and soda, which are of no special interest, we may mention the conclusions at which he has arrived in the case of alloys. All alloys, without exception, lose their homogeneousness when traversed by the current. Thus, fused plumbers' solder, when electrolized, becomes brittle at the positive pole, and soft and malleable towards the negative pole. The amalgams and alloys of potassium and sodium can be operated upon when cold. The amalgam of sodium decomposes water when taken at the negative pole, but not at the positive. Potassium and sodium alloy, under the influence of the current, solidifies at both poles. Whatever the electro-chemical rank of a metal, if present in small quantities in the alloy, it goes always to the negative pole. The amalgams of gold and bismuth dissolved in mercury may be taken as examples. Whatever the amalgamated metal, it always returns to the negative pole.

II. Applied Chemistry.—The *manufacture of soda* has lately received a new impetus by the discovery that a very slight additional trouble, in one stage of the operations, will enable a large quantity of the soda to be obtained in the pure caustic state; besides effecting a great saving in carriage, the product is obtained in a more concentrated and available form. Dr. Pauli has lately shown how this crude caustic soda may be obtained in the perfectly pure state on the large scale. Three tons of it are fused in a cast-iron pot, and the scum which rises to the surface is ladled off; several of the impurities are got rid of in this way. The pot is kept at a dull-red heat all night, and in the morning the mass appears perfectly transparent, the sides and bottom of the vessel being coated with cauliflower-shaped crystals containing all other impurities originally present in the soda. The clear fused liquid is ladled off from these crystals, and, when cold, is ready for use. The caustic soda prepared in this way is hard and brittle, and can be easily obtained in fine powder; the only impurity which it is likely to contain being a trace of carbonate, it will doubtless prove a valuable reagent in manufacturing, and in chemical laboratories.

The application of chemical knowledge to *the preservation of food* has not received the attention which so important a subject deserves. One of the most ingenious adaptations of this sort is a plan devised by Mr. M'Call, who adopts the old plan of expelling air by boiling, but adds an ingenious contrivance of his own. All who have been condemned to live on preserved meats, are well aware that a little decomposition almost always takes place in them. This is probably owing to the air never having been completely driven out by the steam in the boiling, or to some making its way again into the cases before they are soldered down. Mr. M'Call effects the absorption of any remaining oxygen by placing in the top of his cans a fused lump of hyposulphite of soda, which, being exposed when the can is soldered, is expected, by the decomposition familiar to chemists, to absorb any oxygen left in the vessel.

Carbolic acid, one of the multitudinous bodies obtained in the destructive distillation of coal, has recently been discovered, by Mr. Ashby, to possess certain properties which will no doubt be applied before long to many useful purposes. It seems to be diametrically opposite to oil in its effect upon rubbing surfaces: just as oil is anti-frictional, so carbolic acid is pro-frictional; or, to state it more definitely, as oil appears to keep moving surfaces asunder by interposing a thin film between them, so carbolic acid appears to make them bite and bind by bringing them into absolute contact. The effect may be at once observed by placing a little of the acid upon a perfectly clean and dry oil-stone, and then rubbing the face of a knife upon it. The sensation of the bite is very curious, and gives the impression of the stone and the steel having absolutely nothing between them, or even as if they were positively brought together by some attractive force. The property of carbolic acid may be advantageously applied to the operations of grinding, filing, boring, and sawing, in metal.

A *harmless green pigment*, fit to be employed in confectionery, has long been a desideratum. The following has been suggested as being perfectly harmless, and capable of replacing the very poisonous arsenite of copper. Thirty-two parts of saffron are infused, for twenty-four hours, in 700 parts of distilled water. Then take 26 parts of carmine of indigo, infused in the same manner in 156 parts of distilled water. Upon mixing the two liquids together, a very beautiful green is obtained, which will colour a hundred times its weight of sugar in a very perfect manner. The colour may be preserved for a long time, either by evaporating the liquid to dryness, or by converting it into a syrup.

An *improvement in silvering glass*, which possesses some advantages over the process known as Liebig's, has been published by Mr. Cimeg. He employs a mixture of ammonia-nitrate of silver and Rochelle salt. This is poured carefully upon the sheet of glass, which has been previously cleaned with a weak solution of Rochelle salt. For a few minutes the mixture begins to get turbid, and after another two minutes, silver deposits on the surface of the glass. In about ten minutes the glass-plate will be covered, and, in about thirty minutes, enough silver (about 30 grains per square yard) will be deposited for most purposes. The mixture is then to be poured off, the silvered plate of glass washed four or five times in water, and then set up to drain and dry. When dry, it must be varnished, when the glass is ready for framing.

The *metal cadmium* has as yet been applied to very few uses. The brilliant yellow colour of its sulphide is largely employed as a pigment, but we can scarcely point to any other practical application of it. It has recently been proposed as an addition to pyrotechnic displays. By employing a mixture of 20 parts of saltpetre, 5 parts of sulphur, 4 parts of sulphide of cadmium, and 1 part of powdered charcoal, a composition is obtained which gives a white flame surrounded by a magnificent blue margin. Cadmium is now to be obtained tolerably cheap, being prepared as a bi-product in the manufacture of zinc in Belgium.

GEOLOGY AND PALÆONTOLOGY.

ALTHOUGH every one knows that, at a late Geological period, the whole of England was icebound, probably few have realized the vast duration of the glacial epoch. It is still common in the professor's lecture-room to hear the boulder-clay spoken of as "a great splash"; for the idea of cataclysm, beaten back from every other quarter, has at last found a stronghold in the drift. Believing, as we do, that causation has never been more intense in past time than now, it is with interest we notice a little addition to Britain's glacial history, in a paper by Mr. Smith, of Jordan Hill.

In one of the small Western Isles, called Little Cumbra, consisting of *Trap*, there is an old sea terrace or shore, forty feet above the present sea-level, and from it the rock has been worn and removed at least one hundred feet. Now, quite near the shore, and far from this old cliff, are some large boulders, also of Trap, and one of them is split. Split blocks are common in Switzerland, and appear to have become fractured by falling,—generally from the escarpments of ice-terminating glaciers. Hence, as this block is so distant as to preclude the possibility of its having fallen from any neighbouring height, there are no other explanations of its position and breakage than that it either fell from an ice-escarpment at the time the forty-feet terrace was formed, or that it was dropped from an ice-raft drifting therefrom.

These blocks rest on a surface which had previously been smoothed and furrowed by ice, and the glacial striæ, still to be seen, extend down the shore and dip under the sea.* And, therefore, this conclusion becomes evident, that, since the land has had its present level, the total amount of wearing away of the shore has not exceeded a small fraction of an inch, whereas the old glacial period lasted so long that during the time Cumbra was under its influence, hundreds of feet were removed. It must not be forgotten, however, that in the olden time the cliff was buffeted and worn by the more potent agency of ice, while now it is merely lashed by the sea; but, whatever allowance may be made for this difference, the conviction must still remain that, relatively to the great drift period,

> "This fine old world of ours is but a child
> Yet in the go-cart."

An important piece of evidence, tending to show that the drift was no rapid denudation but a slowly-formed deposit, is the occurrence in it of shells which lived at the time. These have been found in various parts of our islands, but few lists are more interesting than one given by the Rev.

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* Similar glacial striæ are still to be seen on Snowdon.

W. Lister, in a paper on the drift of Wolverhampton; for it is evident that there lived, in the middle of England, the common Purpura, Winkle, Cockle, and other familiar forms, associated with *Astarte arctica* and shells only found in cold seas.

The way fossil animals died, is sometimes one of their most singular features. Frequently chalk-fish not only preserve their natural shape, but have every fin expanded. Often forests of stone-lilies, four or five feet high, have been overturned, like a wood by a tornado; while in some rocks, both the older and more recent fish occasionally strew a stratum as though an entire shoal had suddenly died. With regard to those specimens which seem to have died rigid, the genius of the late Professor Forbes—noticing a fisherman dip his cup over a boat in the Irish Sea to drink, and finding the star-fishes brought up in the dredge were killed on getting into the stratum of nearly fresh water which floated over the salt sea—conceived that fish, when in pursuit of prey or fleeing from enemies, would sometimes get into this upper layer and, becoming paralyzed, perish in rigid extension. The more general destruction of life is not so well accounted for, though the following fact, related by the Governor of Madras, helps in its explanation:—

> "An immense mass of fresh water having been poured into the sea during the season of the south-west monsoon, the fish were thereby killed, and rendered the sea offensive with the smell for some time after. 'The very deep did rot.'"

Probably many of the old local exterminations were due to a like cause.

Ethnologists and antiquaries have long been aware of facts indicating a very recent uplifting of central Scotland. And Mr. Geikie, putting together antiquities, traditions, and geological facts, has endeavoured to show that it has occurred since the occupation of Britain by the Romans. His facts are chiefly these:—Round the coast are old sea-margins, now raised from twenty to twenty-five feet, and, were the land depressed to that amount, the sea overflowing, it would convert into islands a number of low hills having the old Celtic word *inch* (island) incorporated in their names. Then there are traditions that some of these had rings attached to which boats could be moored, and one old man asserted that, when a boy, he saw one of these still hanging to the inland cliff. Moreover, near them, under seven or eight feet of stratified gravel and silt, small rude iron anchors have been found, and, in one instance, an iron boat-hook in no way differing from those now in use. Boats, too, have been found in various places considerably above high-water mark and under several feet of marine deposit. Some of these are the common rude canoe formed by burning out a single tree; but one built with planks showed considerable skill and somewhat resembled a Roman galley; and, singularly, this, found at Glasgow, was associated with the ruder forms, as though belonging to conqueror and conquered.

Further, three skeletons of whales have been found, at a height of twenty-five feet, under stiff clay or silt, and with two of these occurred the remains of deer-horn harpoons, one being eight miles inland. And, besides, an examination of the old Roman walls shows that they were not built with regard to the present sea level, since, in the case of the Antonine Wall, there is now sufficient space between it and the sea, at the Falkirk end, for a body of men to have marched round unperceived, while, both there and at the Kilpatrick end, the sea would wash up near to it were it twenty-six feet lower.

And finally, the old Roman harbour of Camelon, in the valley of the Carron, is now five miles from the sea. Hence it is thought that the upheaval certainly took place long after metal had come into use; while, from the position and nature and the relics of the Roman occupation, there is no reason why the movement should not have been effected since the first century of our era.

Mr. Smith, of Jordan Hill, however, feels certain there has been no movement of the land in historic times; while Mr. Carruthers has proved that the pottery, supposed to have been Roman, occurring in the raised beach at Leith, is really mediæval, and cannot have a higher antiquity than the year 700, while with it occur tobacco-pipes. He thinks the deposit containing these remains is of late and artificial formation. But Mr. Geikie, having since re-examined the locality, adheres to the conviction that it is a regular stratified deposit of sand and silt.

Many years since, some enormous trifid footprints found in the Wealden strata were referred to gigantic birds. But, it having been ascertained that some quadrupeds, such as the *tapir*, place their hind feet exactly on the spots occupied by the fore feet, so as to obliterate the mark and leave impressions as though the creature had but two legs, a suspicion arose that these large imprints would be more accurately regarded as belonging to one of the huge reptiles entombed in the same rocks. Mr. Alfred Tylor has described one of these markings, from Hastings, which measures two feet from toe to heel, and gives a beautifully-distinct impression of the foot. And, on comparing the proportions of the toe imprints with those of the bones of an iguanodon's foot found some years ago by Mr. Beckles, so perfect is the correspondence that it is impossible to resist the conviction that the marking on the old rippled shore and the foot bones may both be referred to the same creature. Mr. Beckles, too, has since described natural casts of foot-marks from the Wealden of Swanage and the Isle of Wight, nearly three feet and a half long, and so distinct as to show not only the toes but the sloping metatarsal bones. He thinks that other Dinosaurians besides the iguanodon made these tracks.

The iguanodon, as restored at the Crystal Palace, certainly has five toes, though comparative anatomists are now of opinion there are two too many. Several other monsters, quite large enough to have made the markings, coexisted with it, but of their feet nothing is yet known.

It appears that these foot-marks do not all occur on the same level, but at probably as many as four distinct horizons.

The exact age of the sandstone blocks known as Greywethers has long been uncertain, though all observers felt sure that these masses, so interesting from their resemblance to the material of the Druid circle at Stonehenge, belonged to some part of the Eocene strata. Now, Mr. Whitaker finds that the places where they occur are exactly those where, by the London clay thinning away, the Bagshot sands would rest on the chalk; so that it is scarcely possible to resist the inference that these great masses of grit are connected with and probably derived from that deposit. As, however, a similar sandstone is found at some places in the Woolwich and Reading strata, which underlie the London clay, it is not unlikely that some may also have come from those beds.

The unknowable is ever becoming a more narrow field, and probably the exact thickness of the earth's crust will soon be as well known as our planet's diameter. Not many years since, it was generally fixed at ten or fifteen miles; then Mr. Hopkins demonstrated, on astronomical evidence, that it could not be less than 800 miles; and, now, Professor W. Thompson has pointed out a means by which a more exact measurement may be made. His argument appears to be that the earth is extremely rigid, for were its entire mass of the rigidity of glass it would yield 7-9ths of the extent to which a perfectly-fluid globe of the same density would be influenced by the lunar and solar tide-generating power; and were it as rigid as steel, it would yet yield 2-5ths of that amount. Hence the actual phenomena of tides would, in the former case, be only 2-9ths, and in the latter, but 3-5ths of the amount which a perfectly rigid spheroid of the same dimensions, same figure, and same homogeneous density would exhibit in the same circumstances. And therefore, by carefully observing the amount of the tides at different stations, it will be possible to determine the exact rigidity of the earth, so that, the density being known, it will not be difficult to arrive at a near approximate knowledge of the thickness of the crust. On this evidence, the Professor inclines to think that the fluid part of the earth must be at a depth of from 2,000 to 2,500 miles.

MECHANICAL SCIENCE.

IMPORTANT experiments on marine screw-propulsion have recently been made in H.M.S. *Shannon*. The experiments in the *Rattler* and *Minx*, in 1843-5, led to the adoption of what is now known as the common screw, and which, in spite of some defects, is extensively employed to the present time. It consists of two "blades," broadest at their periphery and tapering to their junction with the propeller shaft. It is defective in this—that the root ends of the blades (nearest the shaft), being twisted nearly perpendicular to the plane of revolution, cause centrifugal action in the water. The power uselessly expended in this way amounts in some cases to 20 per cent. of the whole work of the engines. To remedy this, in the Griffiths screw, one of the best known of numberless attempts at improvement, the blades are fixed on a large spherical boss, about one-third the diameter of the propeller. Thus a sufficient surface is afforded for the attachment of the blades without twisting them into line with the shaft so as to waste power in centrifugal action. The blades are usually three in number, to diminish vibration, and are broadest at their roots, tapering outwards. In the French navy another form prevails, known as the Mangin screw, and consisting of four blades set in pairs parallel to each other, at a short distance apart. The object of the recent experiments in the *Shannon* has been the determination of the merits of these three forms of propeller.

Trials in 1856 gave for the speed of the *Shannon*, with a common screw, 10·49 and 11·69 knots per hour, with 1,957 and 2,216 horses' power respectively. In the recent experiments the common screw was again tried—first with the leading corners of the blades removed, and then with both corners cut away, so as to approximate their form to the blades of the Griffiths screw. The speed reduced in both cases. The Mangin screw gave a higher speed than the common screw, but caused so much vibration as to preclude its adoption in the English navy. As this appeared to arise from the locking of the water between the parallel blades, an ingenious modification was suggested with Mangin blades set at equidistant intervals round a Griffiths boss. Screws of this form, with three, four, and six blades, were tried: the vibration entirely ceased in the two latter cases, and an increase of speed was gained as compared with the original Mangin.

	Speed in Knots.	Horses' Power.
Common screw (one corner cut)	11·29 ...	2,055
„ „ (both corners cut)	11·08 ...	2,094
Mangin (with two pairs of parallel blades) ...	11·33 ...	2,034
Three Mangin blades on boss	11·49 ...	—
Four „ „ „	11·55 ...	2,021
Six „ „ „	11·24 ...	1,947

The experiments with the Griffiths screw have not yet been commenced.

The *Black Prince* attained in her trial trips a speed of 13·584 knots. The *Warrior* reached 14·354. These mail-clad vessels are so similar that the difference is not easily explained. Nevertheless, both are unapproached by any similar vessels in the world, either in speed or power.

The time-honoured process of riveting for structures of wrought-iron is likely to be gradually superseded by a far more perfect process. In riveting, half the strength of the plate is lost in consequence of the metal punched out for the reception of the rivets. Mr. Bertram has contrived a process which, after many difficulties, is coming into use, and has been employed for parts of the mail-clad vessels now building. In this process the edges of the plates are heated by the flame of two portable coke furnaces and welded, so that no strength is lost. Wrought-iron structures thus constructed will be perfectly homogeneous and seamless.

A cannon of aluminium bronze has been manufactured by Mr. Christophe, and presented to the French Government. The alloy is known to possess extraordinary toughness.

The constantly-renewed discussion of boiler explosions has gradually led to a much better appreciation of their causes, and the theory of Mr. Colburn does not leave much to be desired. Corrosion at or near the water line is known frequently to occur to such an extent as to cause rupture at ordinary pressures; and this would afford an easy explanation of many explosions, were it not that the boiler-shell is frequently torn to fragments and the surrounding buildings demolished in a degree more resembling the effects of springing a gunpowder-mine than the escape of steam at common pressures. Hence gradually-accumulated over-pressure has been a favourite explanation of such catastrophes, and fabulous estimates of the force of the steam indulged in; as, for instance, 1,000 lb. per square inch in the case of the accident on board the *Great Eastern*. Mr. Colburn, however, has shown that there are two stages in the explosion,—first, a rupture at some weakened part of the boiler, and the escape of the contained steam with extreme rapidity, but without violence; next, the generation of a second volume of steam in the highly-heated water suddenly liberated from pressure, which, occurring simultaneously throughout the mass, projects that water upwards so as to strike the boiler-shell with a force proportional, not to the statical pressure of the steam, but to the *vis viva* accumulated in the flying mass. These two stages were accurately observed by an engineer present at the explosion of a locomotive boiler on the North-Western Railway, near Rugby, last year. He noticed the rush of the steam, followed, after an appreciable interval, by the crash of the explosion.

There remain, however, cases in which it is difficult to find any indications of the first rupture assumed by Mr. Colburn. Towards the explanation of these, attention has very recently been recalled to the experiments of Professor Donny, of the University of Ghent. Professor Donny found that if water be completely freed from air its temperature can be raised to 275° Fahr. in the open air without ebullition. On continuing the application of heat, however, the production of vapour is so instantaneous and considerable as to cause an explosion. Now, a large number of boiler explosions are known to occur just as an engine which has been for some time at rest is first started; and long-continued boiling is one method of expelling the air from water. Under such circumstances, it has been urged, a sudden and violent production of steam may ensue, sufficient to determine rupture in boilers known to be safe at their working pressure.

In the French *Moniteur Universel* occurs the following announcement of a new prime mover:—

> "The Lenoir motor, of which the principle is the dilatation of air inflamed by electricity, has just realized the hopes we conceived at the time of its first appearance. An engine of six horses' power, with two cylinders, actuates, at the time we write, the presses of the *Moniteur Universel*."

Some experiments have just been made at Shoeburyness on the penetrative power of shells, the results of which reopen the question of the invulnerability of our mail-clad vessels. It has been fully established that ordinary cast-iron shells will not perforate even comparatively thin plates of wrought iron, owing to the readiness with which they break up; in fact, the *vis viva*, instead of being expended on the target, is wasted in demolishing the projectile, and that so rapidly, that the powder is usually scattered without an explosion. Mr. Whitworth, however, has manufactured some shells of cast steel strong enough to resist this tendency to disruption, and the result is, that they prove to have even higher penetrative power than the ordinary cast-iron solid shot. A 12-pounder shell from a Whitworth gun perforated a 2½ inch, and a 70-pounder a 4 inch armour-plate. It must be observed that these shells were flat-fronted, a form which has been proved to have peculiar penetrating properties. It may be interesting to note here that the only projectiles which have as yet perforated a target representing the side of the *Warrior*, are the 150 lb. cast-iron shot of the 300-pounder (unrifled) Armstrong, with a charge of 50 lb. of powder; and the 270 lb. solid shot of the Mersey gun, with a charge of 75 lb. of powder.

MICROSCOPY.

Spontaneous Generation.—This old theory, which some have endeavoured to reinstate, has been philosophically and experimentally examined by M. Pasteur, who has satisfactorily demonstrated,—1st. That the air of inhabited places contains a greater relative number of fruitful germs than the air of uninhabited regions. 2nd. That the ordinary air contains only here and there, without any continuity, the condition of the first existence of generations sometimes considered spontaneous. Here there are germs, and there there are none. 3rd. There are few or many, according to the localities. Rain diminishes the number; but, after a succession of fine days, they are more numerous. When the atmosphere has been for a long time quiet, germs are absent, and putrefaction does not take place under ordinary circumstances. From all his experiments, Pasteur concludes that powders suspended in the air are the exclusive origin,—the first and necessary condition of life in infusions, in putrescible bodies, and in liquids capable of undergoing fermentation.

On the other hand, Dr. Wyman, Professor of Anatomy at Harvard College, U.S., has tried the same experiments as M. Pasteur, as he asserts, with very different results. He boiled various organic substances,—cheese, beef, hay, pepper, &c., and excluded the air, or purified it from germs, by heat and other methods of treatment, and yet, after a certain number of days, "Bacteriums," "vibrios," and "other living organisms" presented themselves. Professor Asa Gray witnessed the opening of some of the flasks, and satisfied himself of the presence of infusoria in the contents.

Minuteness of Germs.—Some infusoria are not more than the 24,000th of an inch in diameter; and if we suppose that the ova of infusoria, and the spores of minute fungi, are no more than one-tenth part of the linear dimensions of the parent organism, there must be an incalculable amount of germs no larger than the 240,000th or the 100,000th of an inch in diameter. Since, according to Sullivant and Wormley, vision with the most powerful microscope is limited to objects of about the 80,000th of an inch, we need not be surprised if infusoria and other organisms appear in infusions in far greater numbers than the germs in atmospheric dust, visible by the aid of the microscope, would lead us to expect.

Reproduction of Infusoria.—Dr. Balbiani has published some valuable observations upon these minute organisms, and has satisfactorily proved that they are hermaphrodite, but not self-impregnating.* The reproductive apparatus forms a system distinct in itself, and there is no internal generative cavity. M. Balbiani, notwithstanding their minute size, succeeded in extracting uninjured and subjecting to the action of the surrounding water, some of the young eggs of *Paramœcium aurelia* from the parent body, whereupon the egg resolved itself into a vitelline, or yolk, membrane, and a germinal vesicle.

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* "Recherches sur les Phenomènes Sexuels des Infusoires." F. Masson & Fils. (A cheap and interesting pamphlet, beautifully illustrated, which every microscopist should read.—Ed.)

Acari in a Nitrate of Silver Bath.—The extraordinary (supposed) discovery of Mr. Crosse of the generation of acari by electricity has received a curious illustration in the experience of Dr. Maddox, who was astonished to find, in a twenty-ounce nitrate of silver bath, of forty grains to the ounce (for photographic uses), which had been kept for a month in a stoppered bottle, a crowd of little acari, sixty or seventy in number, a little larger than the cheese-mite. That such conditions should be favourable to the development of germs is certainly extraordinary, and contrary to our preconceived notions; yet we have instances sufficient to show that we must not judge of the conditions of the lower classes of animals by those which we find obtain in the case of those higher in the scale.

Migrations of Entozoa.—MM. Pouchet and Verrier have been making experiments upon the metamorphoses of entozoa, and have come to the conclusion of denying the necessary transmission of entozoa as described by most modern zoologists, recurring to the old notion that the cystic (or bladder-like) worms are produced from germs of Tæniæ (tapeworms) which have found their way into places not fitted for them. If the tapeworms of carnivora are due to the cystic worms inhabiting their prey, they ask how it is that sheep, which never devour animal food, sometimes have their intestines so filled with tæniæ as to be absolutely obstructed, as was the case in 1852, during an epidemic in the sheep about Rouen. Again, the number of tapeworms produced often exceeded greatly in number the number of worms given. Thus, in one experiment, one hundred presumed larvæ were given to a young dog, taken from its mother, and carefully isolated. Twenty days afterwards its intestine contained 237 tæniæ, of which the size varied from 4 to 60 millimètres.

Microscopic Writing.—The wonderful machine of Mr. Peters, improved by Mr. Webb, has surprised many, even microscopists, by its results. The real object of this instrument is to produce micrometric lines, which shall serve as tests, being drawn with extraordinary minuteness, and surprising accuracy; the squares traced by the intersecting lines containing a measurement of no greater than the 16-millionth of an inch, but having still sharp and well-defined angles. This is accomplished by a comparatively simple instrument, in which lines or curves traced by a pencil at the extremity of a long lever, are reproduced on glass by a diamond, which, by an arrangement of smaller levers, follows the original tracing, but through an infinitely smaller space. Sentences may thus be written upon glass, which shall be distinctly legible by the aid of the microscope, but yet occupying so small a space that (the number of letters in the Bible being known), it is easily computed that the whole Bible and Testament could be legibly written, on the same scale, twelve times over in the area of a single square inch!

MINERALOGY, METALLURGY, AND MINING.

Mineralogy.—It is curious to observe how often arsenic is found in connection with sulphur and sulphur compounds. The composition of the arsenical sulphur from the solfataras of Naples has been investigated by Mr. T. L. Phipson. This mineral has an orange colour, owing probably to the selenium present. It is only partially soluble in bisulphide of carbon, which dissolves completely the crystallized sulphur of Sicily. It is found, on analysis, to contain 11 per cent. of arsenic, and ¼ per cent. of selenium. The arsenic is doubtless present as tersulphide. Arsenic is frequently found in iron pyrites (bisulphide of iron); and as sulphuric acid is now prepared in large quantities from that mineral, the arsenic is carried on, and contaminates the acid. The mineral fahlerz, or tetrahedrite, which is mainly a sulphide of copper, frequently contains a large per-centage of arsenic.

The isle of Elba appears to be an inexhaustible source of remarkable minerals. Some months ago crystals of garnet were found there, having a very peculiar form. They have recently been described by M. Luigi Bombicci and M. F. Pisani. Garnet crystals in general vary but little in form, the predominating faces being those of the rhombic dodecahedron and of the trapezohedron. In the crystals under consideration, however, the predominating form is the regular octahedron—the same which is so prominent in artificial crystals of alum. The octahedral garnet of Elba is found in serpentine rock, and is nearly always accompanied by chlorite and yellowish epidote. It has the colour of honey; and the new method of spectrum analysis shows lime to be an important element.

An analysis of some clays from the coast of Almeria, Spain, has been made by M. Terreil. They are suitable for porcelain. It is remarkable that they taste of chloride of potassium, although, from their proximity to the sea, one would expect the taste of chloride of sodium to be prominent. Along with them is found a red clay, which, from containing much more alumina and less silica than ordinary clay, possesses refractory properties in the highest degree. Hence it is suitable for furnaces—a very important point at the present time, when metallurgists have a difficulty in finding clays sufficiently fire-proof. Steatite has very recently been proposed as a substitute for fire-clay.

Mica is coming into use in Paris for preserving, silvering, and gilding decorations in churches and public buildings. After being cut to the required thickness, it is coated with isinglass, and the gold or other substances added. It is allowed to dry, and then glued or otherwise cemented to the object to be decorated. A burnisher of agate is used to make it smooth.

Turning to *metals*, we find an announcement that Professor Chandler has discovered a new metal in the native platinum of the Rogue River, Oregon. So far, only very minute quantities have been obtained, and further particulars are required. The discoverer believes it to be probably identical with the one discovered in 1852 by Dr. Genth among grains of platinum from California.

Mr. Phipson, in a letter to M. Elie de Beaumont, draws attention to a specimen of native zinc now in the International Exhibition. The specimen occurs in basalt from Brunswick, near Melbourne, Victoria. It has before been stated by G. Ulrich that metallic zinc has been found near Victoria; and, according to Becker, it occurs also in the gold-washings of the Mitta River.—(H. W. Bristow.) Such cases are remarkable, it being very uncommon to find any readily-oxidized metal in the native state.

The mineral lepidolite, or lithiamica, has been used as a source of lithia. Certain varieties contain more than 1 per cent. of the newly-discovered metal rubidium, and these form a convenient source for obtaining this element and its compounds.

Welsh gold continues to attract increased attention. It is constantly being discovered in fresh localities of the Dolgelly district, and expectation is raised to a very high pitch about the auriferous region. It is variously found in quartz, in lead, in alluvium, and in blende. Since the beginning of 1861, about 7,000 oz. have been extracted from quartz-rock in the district. The value of the precious metal thus obtained is more than £25,000, at a cost of £2,000, exclusive of the royalty of one-twelfth paid to the Crown. At Clogau, lately, no less than 142 oz. were obtained from 840 lbs. of quartz. Later accounts state that the district is now being examined by Mr. Mosheimer, commissioner from California to the International Exhibition. He pronounces the district very favourable, but condemns the mode of extraction used at Clogau. It is said he is so confident of the value of some lodes, that he has purchased large interests, sanguine of being well repaid. Explorers have now found their way to the isle of Anglesea, where there is much quartz that resembles that of the gold-bearing districts.

Metallurgy.—The preparation of cast-steel is attracting very considerable attention. Bessemer's process and modifications of it are fast gaining ground. It has frequently been objected to this process that it did not sufficiently or even sensibly remove the sulphur and phosphorus from the cast-iron. Mr. G. Parry, of the Ebbw Vale Iron Works, Monmouth, has patented certain improvements in the manufacture of iron and steel, one object of which is to get rid of these objectionable constituents. He takes ordinary wrought-iron and raises it to a very high temperature in a melting-furnace along with fuel and fluxes. The heat obtained is much greater than that required to melt the iron, which combines with some of the fuel, and becomes carbonized. By subsequent puddling, much of the sulphur and phosphorus are got rid of along with the carbon. If necessary, the carbonization and puddling are repeated. He thus obtains purified wrought-iron. This may be carbonized in the same manner sufficiently to convert it into hard steel. And from this soft steel is obtained, by re-melting it in a separate furnace, and blowing air through it. By these processes nearly all the pig-iron produced in this country becomes available for the manufacture of cast-steel.

An important memoir on this subject by M. Frémy, well known from his researches on the composition of steel, has been lately read before the French Academy of Sciences. He remarks that steel is growing in importance so rapidly that it is incumbent on any nation wishing to preserve its position, to keep up with the metallurgical science of the day. In employing methods requiring much fuel, France could not successfully compete with England, and his object has been to discover processes which will place his own nation in a more advantageous position. It was formerly considered that the ores of Sweden and Russia were the only ones suitable for making iron destined to be converted into steel; and it was also believed that the iron must obtain from its ore a sort of *propensity* for steel. M. Frémy tried to find out from what this propensity resulted, and his analyses led him to believe that iron required not only carbon, but other metalloids, as phosphorus and nitrogen, in order to become steel. [These conclusions were at the time hotly contested in the Academy.] He came to England on the jury of the Exhibition, and saw Bessemer's process, which left doubts on his mind whether it could be applied to the comparatively impure French iron; but his experiments, conducted on an extensive scale, completely reassured him. It resulted that any iron, if sufficiently refined, could be converted into excellent steel by the necessary processes. He was able in twenty-five minutes to convert French cast-iron, worth about ten francs the 100 kilogrammes, into cast-steel worth 150 francs the 100 kilogrammes. He is careful to say that in every case chemical examination of the iron is necessary in order to find out what constituents require removing, and what require adding.

It is now known that Bessemer is making steel from a hematite pig-iron of the North, infinitely superior to anything ever produced on the old converting principle from the most expensive kinds of Swedish iron. Hence, as a trade circular remarks, "there is great demand for hematite pigs."

There is a belief among practical men in Germany that pig-iron which contains copper cannot be puddled; and it has been said that when one puddler wishes to annoy another, he will sometimes throw into the iron a bit of copper, such as a small coin, and that this prevents the iron from "rising." Dr. List, of America, has observed two instances which go to prove that this belief may possibly be correct. In one of these, where the puddling did not succeed, he found about 0·3 per cent. of copper.

The far-famed swords of Damascus were examples of the wonderful perfection to which the manufacture of steel could be brought, even in a long-forgotten age. The art of manufacturing them was lost for centuries. Besides their elasticity they were valued for the peculiar mixture of light and dark waves on their surface; and it was long found impossible to imitate this appearance. At present, however, blades resembling the old Damascus scimitars, equalling them in temper and elasticity, are made at Solingen, in Germany, the only establishment of the kind in the world. A faggot is first formed of alternate fine bars or wires of iron and steel. It is drawn out, doubled, and twisted several times, and then formed into a ribbon. Two such forged ribbons are welded together, enclosing between them a thin blade of the best cutting English steel. After polishing, the Solingen Damascus blade is dipped for a short time into dilute sulphuric acid, which, by rendering visible the carbon of the steel, produces the wavy surface so much desired. The combined twisted iron and steel gives peculiar toughness to the weapon.

M. Alf. Riche, in studying the difficult subject of metallic alloys, has made use of a new method for indicating the point when a true chemical compound is obtained. He examines various mixtures of two metals, comparing their densities with that which would be expected were no combination to take place. In most cases it is found that there is a contraction; and the point of *maximum* contraction he considers to indicate the existence of a true alloy. By this method he determined the composition of the alloy of tin and lead to be the same as was obtained by Rudberg in a totally different manner.

Mining.—The lamentable accident at Hartley Colliery, in January last, gave rise to a general belief that two shafts are required to each mine for the purposes of ingress or egress. As a result of the outcry, an Act has been passed which compels colliery proprietors to have two separate means of exit from each mine, although the two openings need not belong to the same mine. Fortunately many other dangers are lessened by the use of two shafts, so that the compulsion cannot be considered a hardship.

Many accidents have happened in coal-mine shafts from the breaking of the rope. A great variety of "safety-cages" have been invented, so arranged that if the rope breaks, a set of springs push out arms or levers which grip or wedge fast against the conducting-rods, so that the cage is brought to a stand. One difficulty, however, has arisen from the employment—now becoming very general—of iron conducting-rods, whilst most "safety-cages" were suited for wooden ones. Two or three modifications have, however, lately been brought out, which are intended especially to apply to iron rods, and we hope that they will receive all attention from the colliery proprietors.

PHOTOGRAPHY.

A TRIUMPH OF PHOTOGRAPHIC ART.

PERHAPS some of our readers may think that a record of the various improvements which are made from time to time in the photographic processes would derive additional interest from a description of the results obtained by new applications to the art. Such an account would, however, fill our pages, and leave room for no other subject; for in the present day, everybody and everything is photographed. Objects which require the highest powers of the telescope or microscope for their definition are brought before our eyes in a clear and agreeable picture. Others, again, are reduced from their natural size, and the photographic image is so diminished that the microscope must be employed to render it once more visible to the eye. Some of these works of art are simply curious and interesting; others are also useful. Then, as to persons, we will not ask who *is*, but who is *not*, photographed nowadays? Indeed, we think, it will be obvious to all, that it would be impossible for us to give an account of the various results which are from time to time attained by means of photography. Nevertheless, when extraordinary instances of success are brought under our notice, such as we deem deserving of the attention of our readers, we shall at all times be glad to accord them a portion of our space.

Of these, a striking one is now before us, and it is rendered doubly interesting from its immediate connexion with the general progress of every branch of science. It is a photographic picture of twenty-two gentlemen, leading members of the British Association, who met in Manchester last year, and who are artistically grouped (mostly seated), in the drawing-room of the President, Dr. William Fairbairn.

Some of the gentlemen are personally known to us, and, judging from the speaking likenesses of these, we have no doubt that all are equally perfect. There is a total absence of all stiffness or awkwardness either in the attitudes of the individuals, or in the whole or any portion of the group. One or two appear to be speaking, the rest listening attentively, and, quite contrary to photographic precedents, all appear smiling and good humoured. What renders this still more extraordinary is, that each of the portraits was taken separately, and the picture afterwards compiled by the artist, Mr. Alfred Brothers, of Manchester.

The copy before us is reduced from the original, and is 16 inches by 9 in measurement. The original is 2 feet 9 inches by 1 foot 7½, and its production involved no less than 40 separate printings! The gentlemen thus vividly portrayed are:—J. F. Bateman, Esq., C.E.; Sir R. Murchison, F.R.S.; C. C. Babbington, Esq.; Rev. W. V. Harcourt; Rev. Dr. T. R. Robinson; R. B. Darbyshire, Esq.; Sir David Brewster, K.H., F.R.S.; Alderman Neild; Professor Airy; Lord Wrottesley, F.R.S., &c.; General Sabine; Joseph Heron, Esq.; Professor Miller; M. Curtis, Esq. (Mayor); Alderman Mackie; Wm. Newmarch, Esq.; Professors Hopkins, Sedgwick, Willis, Phillips, John Crawfurd, Esq., and the President, Dr. Fairbairn.

The price of the picture is a guinea, which is about the value of any one of the portraits, for those who take an interest in the persons photographed. The London publishers are Day and Son; Manchester, A. Brothers.

One of the most conspicuous and, at the same time, important results which has made itself apparent, in connection with the display of photographs in the International Exhibition, has reference to the degree of permanence attainable in these works of art, and to the dependence which may be placed upon the photographic system of record. It is an undoubted fact, that a large number of the pictures on view at the Exhibition are becoming rapidly defaced, and are showing the most unequivocal signs of fading; some of these which have suffered most have contracted a uniform yellow complexion; others, at an earlier stage, are fading in patches, and present a kind of mottled aspect; some few of the worst cases have, we understand, been altogether withdrawn by their owners from public inspection. These appearances are by no means limited to the works of one or two operators, nor to the productions of England alone; for the same indications of fading are apparent in the beautiful specimens of photography distributed throughout many of the foreign courts. Numerous instances are observable in which, among several impressions mounted together in the same frame, and subject therefore to the same influences, a few only have succumbed to the trying conditions by which they are surrounded, the rest remaining apparently uninjured.

In searching for the primary causes which are likely to be operating adversely in all these instances, it is not necessary to look far to discover the evidence of a damp atmosphere, and considerable fluctuations in temperature, as being paramount among the causes that have occasioned so much destruction. The glass-plate in front of the pictures is frequently bedimmed with a film of dew, and the mounting cards are, like the photographs, manifestly affected by damp, several of them having become spotted with mildew; this is especially the case with the show-frames of the London School of Photography, and those of Mr. Warner, of Ross. The beautiful view of Buttermere, exhibited by Mr. James Mudd, and hanging beside the former on the same wall, is also the victim of circumstances which are plainly indicated by the growth of mildew on the mounting-card; while, strange to say, an excellent print of the South Stack Lighthouse, by the same artist, and placed contiguous, has resisted perfectly the action of moisture. The other works by Mr. Mudd are hanging chiefly on the central screen in the photographic gallery, where they are considerably less liable to be affected by damp, and have consequently preserved all the delicacy and beauty of toning for which the photographs by this gentleman have long been celebrated.

The same remark applies to the pictures exhibited by Mr. Vernon Heath; to the views in North Wales, by Mr. Henry White, and by Mr. Sidebotham; to those of Mr. D. Campbell, of Ayr; and likewise to the exquisite landscapes in Madeira, by Mr. R. M. Gordon: none of these disclose the least symptom of fading, and all are placed upon the central screens. In like manner, with regard to the portraits by Mr. T. R. Williams, and to the magnificent series of abbeys and cathedrals by Mr. Francis Bedford, not one of these shows the least indication of fading; but it must be stated that they occupy the more favoured position in the centre of the gallery.

A remarkable instance of the formation of mildew is apparent on the leather binding of a book exhibited by Mr. A. W. Bennett, and entitled "The Ruined Abbeys and Castles of Great Britain, illustrated by Photography." This book is inclosed within a glass case, and hangs directly in contact with the wall. Some few of the exhibitors appear, however, to have adopted the suggestion of Mr. G. Wharton Simpson, and have inserted pieces of cork between their frames and the objectionable wall; the advantage gained by this precaution is already manifest by the protection afforded to these prints.

As the general conclusion, from observations made upon the photographs now on view at the International Exhibition, it must be admitted, that the security of a photographic record depends, not merely upon the amount of care bestowed originally upon its preparation, but quite as much upon its being preserved in such a manner as to exclude, as far as possible, the adverse influences of damp, or actual contact with moisture, produced by condensation on the front glass: conditions to be fulfilled which, as yet, do not appear to have received their merited share of attention.

The quantitative question, in reference to the amounts of silver and gold necessarily expended in the operation of photographic printing, has received some further elucidation, by experiments lately made in this direction by Mr. John Spiller, assistant chemist to the War Department, at Greenwich. The practical conclusions established by this gentleman's analytical results are to the effect, that upwards of eighty per cent. of the silver originally employed in the process of sensitizing the paper may be recovered in the state of precipitated chloride and sulphide, by judiciously collecting the various washings and waste solutions, and treating them with common salt; or, in the case of the fixing baths, and other solutions containing hyposulphides, with crude sulphide of potassium. These products being separately reduced to metal, are stated to yield in the aggregate the large amount of silver indicated, from which the pure nitrate may be again prepared, and, at the same time, a certain proportion of gold rescued for further employment in the toning process. By adopting the suggestions of the author, it appears that of the fifty grains of nitrate of silver ordinarily taken up by the full-sized sheet of albumenized paper, at least forty grains are recoverable, and that, at the rate of four shillings per ounce troy, one pennyworth of silver need only be actually expended in the production of a single proof of the largest possible size (seventeen by twenty-two inches).

The most striking improvement in construction which we feel called upon to notice is one referring to the camera. In the ordinary form of the double-bodied instrument, it has hitherto been customary to make the hinder portion slide within the front case, to meet the adjustment for focus; but, by reversing this arrangement (which is now becoming a general practice), the lens and smaller front part of the camera are made to travel forwards by the action of an endless screw in the base board, the ground glass remaining stationary, by which means the operation of focusing is more readily accomplished than when, on the old plan, the image is constantly approaching or receding from the eye. Another advantage gained by this arrangement is, the increased accommodation provided for the reception of the plate-holder at the back of the camera, and the possibility of taking therein pictures of somewhat larger dimensions, on account of the interior form of the instrument humouring, instead of being opposed to, the direction taken by the rays of light diverging from the lens. The large camera, made on this principle by Mr. Dallmeyer, and shown in the nave of the International Exhibition, is one among many illustrations of this novelty in construction.

PHYSICS: LIGHT, HEAT, AND ELECTRICITY.

A PAPER, by A. J. Angström, has been communicated to the Editor of the *Philosophical Magazine*, "On the Fraunhofer's-lines visible in the Solar Spectrum." He repeats the statement, "that a body in a state of glowing heat emits just the same kinds of light and heat which it absorbs under the same circumstances;" and considers that "the electric spectrum must be viewed as the superposition of two spectra—

the one belonging to the metal or conductor of which the electrodes are made; and the other, to the gas through which the spark passes." The object of his present investigation was to make a new examination and accurate drawings of the solar spectrum; to determine the wave-lengths of many of its lines, and also of the lines in the spectra of different metals. He has confirmed the statement of Kirchoff—that the atmosphere of the sun contains iron, magnesium, nickel, and chromium; the lines due to iron "are the most characteristic in the whole spectrum." He adds, as a result of this last research, that calcium, aluminium, and manganese exist in the sun; and also, in all probability, strontium and barium; and concludes by some remarks on "Fluorescence."

Mr. J. Attfield has examined, by the aid of prismatic analysis, various flames containing carbon, and has found that ignited oxy-carbons, hydrocarbons, sulpho-carbons, and nitro-carbons emit certain rays of light in common; and concludes that these rays emanate from ignited carbon vapour. When observed by the unassisted eye, the prevailing colour of ignited carbon is light blue. By special manipulation, he has obtained the carbon spectrum with carbonic oxide, olefiant gas, bi-sulphide of carbon, and cyanogen.

M. Jaunsen, in a note communicated to the French Academy of Sciences, affirms that he has recently been able to determine the presence in the solar spectrum of permanent rays which ought undoubtedly to be attributed to the action of the terrestrial atmosphere, and has constructed a spectroscope by which he has been enabled to examine these rays or bands, moment by moment, from sunrise to sunset, and has found them to vary in intensity with the height or thickness of the atmosphere through which the sun's light has to pass.

Some time ago, Gladstone examined the nature of light which had passed through dilute solutions of nitrate of didymium, and discovered two dark lines in it by spectrum analysis; and Professor Rood, of America, has lately repeated the experiments with a strong solution of considerable thickness of the same substance. He has found that when sunlight or lamplight is transmitted through a thickness of twelve inches of this strong solution, and analyzed by Kirchoff's spectroscope, the spectrum is seen crossed by twelve distinct lines, some of which are very broad and others very fine. D, or the sodium line, is just cut off by one of these, and from this results the singular phenomenon that a sodium flame is invisible through a foot thickness of this liquid, although the liquid is nearly colourless and scarcely at all alters the tint of ordinary white objects viewed through it.

In our last number, we stated that a French commission had examined and commended M. Serrin's newly-invented regulator for electric lights; since then, M. Serrin has exhibited his electric lamp at the Polytechnic Institution, London, and all agree in stating that the light emitted was perfectly steady and uniform in intensity—a result which has never heretofore been perfectly obtained with an electric lamp, and which was in the highest degree desirable. The following are some particulars of the structure and action of the lamp from a published description of it by M. Serrin; and those who are acquainted with the mechanism of such lamps will at once perceive that it does not differ from them in many respects. The two carbon electrodes are vertical, the upper or positive one being fixed; the lower one is attached to the armature of an electro-magnet, and is capable of moving up and down vertically within a space of about one-tenth or one-eighth of an inch; it is supported at the required height by two springs, which are capable of adjustment by means of a screw, and is drawn downwards by the attractive force of the magnet upon the armature when it approaches too near the upper electrode; it requires a weight varying from 150 to 460 grains to depress the armature, according to the degree of tension imparted by the screw to the second spring. The apparatus is very solid and durable.

The development of the marvellous power of the electric induction coil is still progressing, and it is impossible at present to say how much further it will proceed. It began but a few years ago to excite attention, when sparks half an inch in length were obtained by Rhumkorff, in his admirable apparatus, by means of superior insulation and greater length of wire; from that time many investigators have been engaged in extending its power: Mr. Hearder, of Plymouth; Dr. Callan, of Maynooth; Messrs. Bentley and Ladd, of London, and others, gradually increased its power of giving sparks to a distance of about five or six inches; and Mr. Ritchie, of Boston, United States, in a large coil which he made for Mr. Gassiott, of London, by winding the enormous quantity of fifty miles of fine wire on his coil in a peculiar manner, obtained sparks about twelve or fourteen inches long; and even this length of spark has been considerably exceeded by Rhumkorff, who has obtained sparks nineteen inches long. Recently, however, at the last *conversazione* of the Royal Society of London, a very remarkable coil was exhibited by Mr. Siemens, and excited great admiration, which has altogether surpassed previous attainments in this direction. First, we will take the effects said to have been obtained by it, and then briefly describe its construction and peculiarities. On the evening in question, with two elements or cells of Bunsen's battery connected with the primary coil, the two wires of the primary coil being connected parallel, sparks were obtained twelve inches in length, and, with six elements, they were thirteen inches and a half long; but, by connecting the two primary wires as one continuous wire, the sparks were increased in length to nineteen inches; the electricity then escaped in brilliant flashes of light through the air from many parts of the coil. On the above occasion, the coil was not worked to its full power, in consequence of the batteries being hurriedly prepared, and therefore did not give the maximum length of sparks. On a previous occasion, the following effects were stated to have been obtained:—A single Bunsen's element gave sparks 8·4 inches long; two elements, 15·6 inches; three ditto, 19 inches; four ditto, 20·4 inches; five ditto, 22 inches; and six ditto, 23·2 inches.

In all cases with this coil, the mechanism for making and breaking contact is worked by a separate battery consisting of Daniell's elements, and the contact at the break is made by a platinum point, dipping into a vessel containing mercury amalgam covered with spirits of wine. The plates of the Bunsen's battery for exciting the coil were about ten inches wide. The iron core of the coil is 37·4 inches long, and 2·36 inches diameter, and consists of varnished straight iron wires 0·05 inch diameter. The outer diameter of the coil is about 8 inches. The primary coil consists of two parallel insulated copper wires 0·1 inch thick, and may be connected either as one wire of the total length, or as a double wire of half the length. The primary coil is surrounded by a cylinder of ebonite, which is thicker at its ends than at its middle, to resist the greater tension of the electricity at those parts. The secondary coil consists of 11,762 yards, or 6·88 statute miles, of insulated copper wire, of 0·006 inch diameter, and is wound upon the ebonite cylinder in 299,198 turns; its total weight is 64 pounds. The great power of the coil depends largely upon the arrangement of the secondary wire, which is as follows:—The space outside the ebonite cylinder is divided into 150 narrow and deep grooves, by means of thin, flat, annular discs of ebonite, which fit closely upon the cylinder; the fine wire was wound into each of these adjacent spaces alternately in opposite directions, until they were all filled, connecting each section of wire at the bottom of the groove with its neighbouring section on one side, and at the top of the groove with its other neighbouring section on the other side, and so on throughout the entire series, so as to form one continuous wire. This separation of the secondary coil into numerous sections by a powerfully insulating material greatly increases the resisting power of the insulation; the plan also of winding each alternate section in opposite directions is also of great value in a similar aspect. The condenser consists of several discs of paper glued together, and covered with tin-foil, the surface of the two tin-foil coatings being equal to sixteen square feet each; the condenser of this apparatus does not much affect the length of the spark, but is important to prevent the mercury of the break contact from being violently thrown about. Owing to the peculiar construction of this coil, greater effects are obtained with seven miles of secondary wire than had been previously obtained, in some other coils, with fifty miles; the leading principle of its construction appears to have been, to proportion the amount of resistance to the amount of tension in all its parts.

Mr. Siemens also exhibited a new telegraphic instrument remarkable for rapid transmission of messages through long circuits: it is worked by means of magneto-electric currents, and each signal requires two currents, one positive and one negative, to produce it; the code of signals is that known as "Morse's alphabet." Eighty words per minute were transmitted through a resistance equal to 3,000 statute miles of underground wire. It is said that a speed of 400 letters per minute may be accomplished, day and night continuously, by means of this instrument.

M. Becquerell has exhibited to the French Academy of Sciences specimens of metals obtained by electrolysis, accompanied by a memoir describing the methods he adopted to obtain fine specimens of cobalt, nickel, silver, gold, and platinum. The plan he adopts is to decompose concentrated solutions of the respective metals by currents of very feeble intensity, thus avoiding tumultuous deposits, and enabling the molecules to group themselves regularly and firmly; the intensity of the currents he employs varies with the density of the respective solutions.

Mr. Gore has described, in the Proceedings of the Royal Society, "two additional kinds of electro-deposited antimony possessing the property of evolving heat: one of them is obtained from a solution of bromide, and the other from a solution of iodide of antimony," and has given "additional information respecting the peculiar heating-antimony obtained from the aqueous terchloride." The manifestation of heat is greatest with the one from the chloride solution, and least with that from the iodide. An explanation is also suggested of the mode of formation and action of these singular heat-giving substances.

Dr. Frankland has made various experiments on the "Igniting Point of Coal-gas," and has found that coal-gas cannot, even under the most favourable circumstances, be inflamed at a temperature below that necessary to render iron very perceptibly red-hot by daylight in a well-lighted room, but this is considerably below a red-heat visible in the open air on a dull day; and this high temperature necessary is chiefly due to the presence of olefiant gas and other hydro-carbons in the coal-gas. Explosive mixtures of coal-gas and air may be inflamed by sparks from metal and stone, as from the tools of a workman excavating the ground, &c. Explosive mixtures of the gas of coal-mines and air require a far higher temperature for ignition than similar mixtures of coal-gas and air; and, therefore, the use of the safety-lamp is far more effectual in the former case than it would be in the latter.

The last ascent of Mr. Glaisher in a balloon, at Wolverhampton, is full of interest: he ascended to the unprecedented height of upwards of six miles, the reading of the barometer being at that height about eight inches; the temperature of the air was exceedingly low, at least thirty-seven degrees below the freezing-point of water; the readings of the instruments at the very highest point were rendered impossible by Mr. Glaisher having become quite unconscious, and Mr. Coxwell, the aëronaut, nearly so, indicating that an altitude of between five and six miles is nearly the limit of human existence.

Professor Chadbourne, of America, has shown that, if a spoonful of dry powdered ice or granular snow be thrown into a smooth glass vessel nearly filled with water slowly boiling, strong ebullition is produced, the particles of ice or snow acting like particles of iron or sand would under similar circumstances.

A discourse was recently delivered, at the Royal Institution, by Mr. Faraday, "On Gas Furnaces," and was chiefly devoted to an explanation of the construction and action of the "Regenerative Gas Furnace" of Mr. W. C. Siemens, of London. This arrangement of heat-generator is rapidly becoming employed for all great furnaces where a very high degree of heat is required, such as in iron puddling, iron-tube welding, glass-making, &c., chiefly in consequence of its economy in enabling the very commonest kind of coal (called "slack") to be employed instead of a better quality, and with the production of a very much greater degree of heat,—so great, indeed, that on several occasions, when its management has been neglected, the most refractory clay-vessels have been softened and destroyed.

ZOOLOGY.

The Posterior Lobes of the Brain in the Lower Animals.—The controversy raised by the statement of Professor Owen, that the posterior, or third, lobe of the cerebrum (brain proper), is peculiar and common to the *genus homo*, and that certain parts found in the hind lobe are equally restricted to man, still attracts the attention of physiologists and comparative anatomists. Dr. Turner, Demonstrator of Anatomy at Edinburgh, agrees with the opponents of Professor Owen, that it is now fully proven that the Quadrumana (monkeys) possess a posterior lobe, with its characteristic parts. He has also found very decided posterior lobes in the cerebrum of certain Cetacea (whales), as well as a high degree of complexity in the convolutions of the brain.

In-and-in Breeding of Domestic Animals.—It is a generally received opinion that in-and-in breeding, while it is extremely injurious in the case of the *genus homo*, is not accompanied by similar evils among domestic animals. A contributor to the *Comptes rendus* speaks thus forcibly upon this subject:—"Breeding in-and-in is, under no circumstances (as has been advanced by a forced interpretation of what passes in domestic animals), a practice favourable in itself, and altogether without danger. Far from it, it is for all species a cause of degeneration and decay. It is useful sometimes to have recourse to it as a necessary evil, to which one must submit in order to reap a counterbalancing advantage; but the practice should be discontinued as soon as there is no longer an absolute necessity for it."

The Unicorn.—Dr. Baikie, the African traveller, announces that he is upon the track of this, as hitherto supposed, fabulous animal. Writing from Central Africa, he says that several years ago he heard allusions to such an animal, as he ascended the Niger, which were so circumstantial that his scepticism was shaken, and, at all events, he is disposed to hold that its non-existence is *not proven*. Two informants told him they had seen the bones of such an animal, particularly describing the long straight (or nearly straight) black horn. He states that the hunters are well acquainted with the one-horned rhinoceros, and carefully distinguish between it and the presumed unicorn. No doubt the vast forests and unexplored wastes of Central Africa contain many unknown animals, and Dr. Baikie gives a list of native names by which this strange creature is called in various African dialects.

The Aye-aye.—The most remarkable addition made of late to the stock of living animals at the Zoological Society's gardens is an Aye-aye (*Cheiromys Madagascariensis*). This extremely rare and curious nocturnal animal has only comparatively recently been known even to the natives of the islands which it inhabits. Mr. Edward Mellish, of the Mauritius, going on a mission of congratulation to King Radama II., on his ascent of the throne of Madagascar, took such effectual steps, that, although he could not at that time procure a specimen, one shortly afterwards was forwarded to him, which has reached London alive and in good health.

Sounds produced by Mollusca.—The lakes of Ceylon contain shell-fish which, Sir E. Tennent informs us, produce remarkable sounds, referred by the Cinghalese to species of the genera Littorina and Cerithium. Similar sounds have been observed in South America; and a recent observer in the North, about Vancouver's Island, has discovered the existence of a similar musical mollusk in an arm of the sea running out of Victoria harbour. The sound was compared to that of a Chinese kite when flying, and which is produced by fixing pieces of metal to the kite's tail. The Indians were well acquainted with the sound, and referred it, like the Cinghalese, to a shell-fish, but the observer had not hitherto been able to obtain specimens.

The Young Fry of Anodonta Cygnea.—A remarkable fact in the history of this fresh-water mussel has been brought to light, viz., that the young fry are parasitic upon fishes. At the time of the exclusion from the ovum, says the Rev. W. Houghton, they keep constantly snapping together their valves, reminding one of the somewhat similar action of the *birds' heads* upon some of the marine polyzoa. After it has once snapped upon the fin of an unfortunate fish it appears to be quite stationary. In this condition they appear to be identical with long-known little creatures called *Glochidia*, from the two hooks which they possess, and deemed truly parasites. These hooks being barbed, it appears that the little mussel, having once fixed upon a fish, is unable to re-open its valves. It is not known how long they remain in this parasitic condition, nor what changes they undergo before becoming adult anodontæ.

Acclimatization of the Silk-worm.—M. Blani, of the department of Marne et Loire, describes in the *Revue et Magasin de Zoologie*, the success with which a species of silk-worm (*Bombyx Cynthia*) has been reared at Anjou. He describes the appearance presented by the worms covering the branches of trees largely cultivated for that purpose. As many as 500,000 worms were placed upon the trees, and were doing well; most of them had changed their skin three or four times, and some were already spinning their coccoons among the leaves. The tree on which these insects feed is the Ailanthus, (natural order *Xanthoxylaceæ*), a native of China, but very hardy and easily acclimatized.

The Agricultural Society of Indre et Loire has voted a sum of money for the cultivation of the mulberry, in order to increase the food of the true silk-worm (*Bombyx mori*).

Diseases of the Silkworm.—These occupy to a considerable extent the attention of the silk cultivator. It has recently been discovered that uric and hippuric acid in the blood of the moth is a frequent cause of sickliness. The morbid product ceases to show itself when the insects are supplied with good food in the open air.

New Mygale.—A new British species of this genus of spider has been found at Brighton—*Dysdera erythrina.* Previously only one was known in England. These insects are remarkable for the caves some of them construct of earth, having a distinct door or lid; and for the probably fabulous tales of some of the larger species' propensity for *catching birds.*

Borings of Limnoria terebrans.—This minute crustacean, which, though only two lines in length, exists in such numbers, and is so destructive in its boring propensities, as to cause great havoc to ships and submarine wooden structures, has hitherto been supposed to have received a check from Bethell's patent creosote process. Mr. D. Stevenson has, however, stated, as the result of his experiments, that he has now ascertained beyond all doubt that creosote is not a universal or permanent preservative of timber used in marine works.

Anatomy of Sponges.—Dr. Bowerbank, who is well known to have long paid much attention to this lowly order of organisms, rejects the term Amorphozoa, or shapeless animals, proposed by De Blainville, adopting instead that of Dr. Grant, viz., Porifera, as the porous mode of imbibition of nutriment is universal in the class. He divides sponges into three classes, according to the nature of the skeleton, placing those first which contain calcareous spicula, the siliceous sponges second, and those with a horny structure, formerly placed first, are degraded to the lowest rank.

Physiological Teaching in the Higher Schools.—Dr. Acland, Regius Professor of Medicine at Oxford, has addressed a letter to the teacher of physiology in the grammar school of Magdalen College, in which he strongly advocates physiological study; and, as the best method, he recommends the collection of the Fauna and Flora of the neighbourhood, dissections of common animals, and microscopic research. He proposes to have precise osteological monographs of common typical animals, written by experienced physiologists, and illustrated with *objects*, instead of plates, which, though they would be more costly, would at the same time be more durable. In connection with this subject, we may call attention to the useful and interesting series of illustrative dissections, by Mr. Charles Robertson, of the Oxford University Museum, which may be seen in the Educational Department of the Great Exhibition. These are precisely the kind of illustrations required, and might be prepared in any number by Mr. Robertson, or by Mr. Flower, of the Royal College of Surgeons.

POSTSCRIPT.

Since our Astronomical Summary went to press, the following additional intelligence has been forwarded to us:—

A new planet has been discovered by M. Luther, but, being near the position of the lost "Daphne," it has not yet been decided whether it is the latter or a hitherto unknown object.

The transits of Titan's shadow have become a matter of some curiosity during the disappearance of Saturn's ring. It has been placed beyond doubt that they are well seen even in common telescopes. On April 15, Mr. Gorton observed this phenomenon with a telescope of 3¼ inch aperture, and a power of 170 and afterwards of 100, and says that the shadow of this satellite was almost as easily seen as a similar appearance on Jupiter. Mr. Dawes computes the synodic period of this satellite at 15°,967. The latter observer considers, from recent observations on the ring of Saturn, that this portion is of almost inconceivable thinness, and much less than the forty miles ascribed to it by Professor Bond. Mr. Dawes imagines, also, from the appearances observed by him, "the existence of a pretty damp atmosphere on the rings," which, by the refraction of the light of the sun, would account for the visibility of the ring even when the illuminated surface is turned towards the earth.

Mr. Huggins draws attention to the *inactive* state of the clouds and belts of Jupiter in 1858 and 1859 as compared to the changes which were constantly going on during its last appearance. As both Jupiter and Saturn will be visible during the coming winter months, the before-mentioned phenomenon will doubtlessengage the attention of many of our readers.

NOTES OF THE EXHIBITION.

No. V.

THE MACHINERY DEPARTMENT.

BY WILLIAM FAIRBAIRN, LL.D., F.R.S.

NO section of the Great Exhibition afforded so deep an interest to all classes of the British public as the Machinery Department.

Whilst in other divisions it was the object of our neighbours to excel us, all they could hope to do in the province of mechanical engineering was to stand on the same level, and compete with us in a friendly rivalry of skill in constructive art. In many instances they succeeded; but we believe that every connoisseur of the subject who visited the Exhibition, and every reader of the following remarks, will agree with us in thinking that, notwithstanding the rapid and creditable progress made elsewhere, Great Britain still holds the proud position of being at the head of nations in mechanical appliances and engineering proficiency.

A word of apology before we commence our task. Amongst the numerous readers of this Journal, many are well acquainted with the technicalities of natural science,—less, probably, with those of the engineering arts; and if here and there we have been led to employ terms of a technical character, it must be remembered that we are dealing with embodiments of the conceptions of the most advanced minds of the day, and we are compelled to refer to the application of principles which few can fully understand.

As far as possible, however, we have endeavoured to steer clear of abstruse subjects; and if we should occasionally touch upon principles, or their applications, which some of our readers do not fully comprehend, we hope that they will be tempted to inquire further and make themselves masters of their precise character.

In order to enable our readers to form a clear conception of the advanced stage to which the mechanical operations of the engineer have attained, it will be necessary to examine —

1st. The sources from which we obtain the elements of motive power, comprising the steam-engine, its varieties, forms, and application.
2nd. Water-power, as exhibited in water-wheels, turbines, and other hydraulic machines.
3rd. Grinding, crushing, and cutting machines.
4th. The machinery for the manufacture of textile fabrics.
5th. Locomotive machinery and railway plant.
Lastly. The machinery of agriculture.

In following these divisions of our subject, we have for the source of all power the heat of the sun, which, according to the last new theory of Professor W. Thomson and Mr. Waterton, is produced and maintained by a constant shower of meteoric matter which falls into that luminary. Assuming this to be true, a continuous supply of cosmical heat will produce any description of motive power, which we convert into mechanical force by the combustion of fuel, and by this and other contrivances abate the necessity for muscular exertion in man and animals. To the same source may be traced the vivifying principle of animal and vegetable life; and the deposits of past ages, which we are now using as an agent of accumulated force or work accomplished, and which constitute, in almost every case, the necessary conditions where motive power is required. To the labours and experiments of Black, Carnot, Mayer, Regnault, and Joule we are indebted for the two principal laws of thermo-dynamics, which are, according to the construction of Mr. Mallet, thus stated, namely :—

> That heat and mechanical force are reciprocally convertible, and heat on being evolved, requires, or when it disappears, returns in mechanical force, an equivalent of 772 foot-pounds for each English thermal unit, viz., for the heat of one degree of Fahrenheit's thermometer in one pound of water.

In other words, an increment of heat that will raise the temperature of one pound of water one degree is equal to raising 772 lb. one foot in height. This is Joule's equivalent, and has now become general as a measure of work done in foot-pounds.*

Steam and steam-engines are the most important agents now in use as a motive power in Great Britain, and from these alone we receive nearly the whole of the force that is at present in operation in manufactures, steam navigation, locomotion, and mining. The extent of this force, in this country alone, has been differently estimated. In 1859 it was nearly as follows:—

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* The resistance of one pound overcome through a distance of one foot is called a foot-pound.

Steam-Engines employed.	Horses' Power.	
	Nominal.	Indicated.
In Mining and Metal Manufactures.........	450,000	1,350,000
„ Manufactories...	1,350,000	4,050,000
„ Steam Navigation................................	850,000	2,550,000
„ Locomotion..	1,000,000	3,000,000
Total............	3,650,000	10,950,000

Or about 11,000,000 horses' power, raising 33,000 lb. one foot high in one minute, or equivalent to the enormous force of raising 162,053,575 tons one foot high in one minute, or 1,620,535 tons to the height of 100 feet in the same time. This was estimated as the work done per minute three years ago; now it has increased to upwards of 12,000,000 horses—which may be taken as the motive force in the British isles alone.

It would be interesting to know the quantity of coal consumed for the purpose of generating a force equivalent to raising the above enormous load of 9,723,214,500 tons one foot high in an hour. This, as already stated, would require the strength of 11,000,000 horses to accomplish in one hour, and this multiplied by five, the average consumption of coal per hour per horse-power, gives 24,533 tons, or about 25,000 tons, as the rate of consumption per hour for the steam-power of Great Britain and Ireland.*

Steam-Engines are of three classes,—Stationary, Marine, and Locomotive; and these are again subdivided into Condensing and Non-condensing Engines. Nearly all at the present time work the steam expansively; that is to say, they are so arranged in the construction of the valve motions, as to cut off the communication with the boiler at one-third, one-half, or two-thirds of the stroke, as the case may be, in regard to pressure, or the power to overcome the resistance of the load. Some engineers go so far as to cut off the steam at one-sixth and one-eighth, and expand the remaining five-sixths or seven-eighths of the stroke.† The expansive system is now thoroughly understood, and is in almost every case resorted to, with a great saving of fuel. Of late years the principle of expansive working was very imperfectly understood, and the result of its introduction was an immense economy; for more than double the quantity of work is now done with the same quantity of fuel, of what was formerly accomplished on the old non-expansive principle. It must, however, be borne in mind, that this cannot be effected without an increase of the pressure of steam, and hence follows the necessity of having the boilers of increased strength and improved construction. The neglect of these precautions has resulted in serious and fatal accidents, attended with a considerable loss of life and property.

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* *Vide* "Useful Information for Engineers," p. 206.

† The distance which the piston travels is called the stroke, and is twice the radius of the crank.

Irrespective of increased pressure, and working the steam expansively, the speed of the engine has been increased about one-third since the days of Watt. In his time the piston of the stationary engine travelled at the rate of 240 feet per minute; now it averages from 300 to 320 feet, and this, combined with high-pressure steam worked expansively, increases the power of the engine, in some cases, upwards of twofold, and, as already stated, doubles the quantity of work done with the same quantity of fuel. Thus an important saving is effected to this and every other country where steam is employed as an agent of power and motive force.

Having ushered in our observations with these necessarily technical remarks, we may state that the Exhibition of this year does not present any new nor original conception in the construction of stationary engines, with the exception of the non-condensing engines, which, in this case, have their cylinders horizontal instead of vertical, as exhibited in the old construction. There are some advantages in this, as the cylinders of the non-condensing engines are comparatively small, and are less liable to wear oval than would be the case in the large condensing engines. These engines are, however, chiefly used as assistants to the stationary condensing engine, and effect a saving by the steam being employed twice over, for it first propels the piston of the high-pressure horizontal engine, after which it is conveyed to the cylinder of the large condensing engine, where it finishes the work at a considerably reduced pressure.

These double engines are mere substitutes for the compound engine of Woolf,* with this disadvantage, that considerable loss is sustained by condensation in the transfer from one engine to the other; and taking into account the back pressure and other causes, this combination is less effective than the united compound engine. But exclusive of these drawbacks, it is found from practice that the non-condensing engine does nearly the whole of the work, and in many instances drags forward (if we may use the expression) the piston of the old condensing engine along with it. The work done by the larger engine is, therefore, nil, or little more than what is gained by vacuum and condensation. In the Woolf or compound principle, this is not the case to the same extent; but it yet remains to be solved what benefit there is in a more expensive and more complicated construction, when the same advantages can be obtained by the single cylinder.

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* Woolf is the inventor of the double-cylinder engine.

That is the question for solution, and to which the advocates of the double cylinder reply, that in working with high-pressure steam, the force applied to the piston of the first cylinder is diffused over a much smaller area, and the action is less severe upon the working parts of the engine than if forced, with the velocity of impact, upon the surface of a greatly enlarged piston, as in the case of the single-cylinder condensing engine. This, to a certain extent, is correct, only it does not effect the economy but simply the strength of the working parts of the engine. Again, it is stated that the double-cylinder engine produces from the same cause a more uniform motion than the single-cylinder engine. But the advocates for the single-cylinder system affirm that these objects are all attained, first, by cutting off the steam at a point that will produce the same rate of expansion as in the compound engine, and this, although suddenly effected, is fully compensated by the action of the fly-wheel, at the greatly increased speed of the engine.

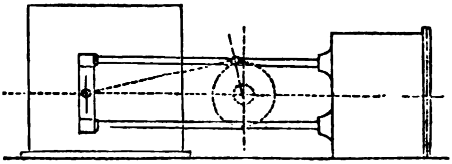
We have been the more particular in this description, as the question is not yet settled amongst practical men which of the two systems is the best; each side has its advocates, with proofs which they adduce in confirmation of their respective theories. Without entering further into this question, we may, however, state that we would prefer the single-cylinder engine, where the advantages are the same as those of a more complicated form; for it appears to us that no benefit is gained in the shape of economy by the double or the compound engine; on the contrary, we are inclined to believe there is a loss in the former, owing to the difficulty of working them together as one engine. The same reasoning will apply to what is called the M'Naught principle, which consists in placing a high-pressure cylinder at half-stroke, under the main working beam of the ordinary condensing engine, and exhausting the steam from one cylinder to the other, on the same principle as already described in the double, horizontal, and vertical system.

Having described the different forms and conditions of our stationary engines, and the improvements that have been effected by the introduction of high-pressure steam worked expansively, we may conclude this part of the subject by observing, that we are far from arriving at that point of economy in the use of steam which an increased pressure and a still greater expansion is calculated to attain. It is true that the danger of explosion may be increased, and so it would with our present means; but in our locomotive engines we already work steam at 200lb. pressure on the square inch with greater safety than is done in our stationary engines at a reduced pressure; it is, therefore, evident that we are behind in this department, and a wide field is still open for improvement. It is not our province in this article to point out how this can be accomplished, but we may safely affirm that the improvements already attained are only the precursors of others of much greater importance in the economy and use of steam.

Marine Engines.—In this department of constructive art this country stands pre-eminently forward in advance of all others at the Exhibition. It is not the principle nor yet the power that attracts notice, but the application, design, and construction of a machine calculated to propel a vessel of 6,000 tons burden, at a rate of from fourteen to fifteen knots an hour, and yet so small and so compact, compared with the magnitude of its force, as to excite the admiration of every beholder. In this department of mechanical science we have, concentrated within a space little more than twenty feet square, a force equivalent to 2,600 indicated horses' power, and that with all the conveniences of approach to every part of these powerful machines.

For examples of engines of these colossal dimensions and compact form, we have only to refer the reader to those of Penn, Maudsley, Rennie, Humphries, and others, to convince him of the superiority of their construction, the mathematical accuracy with which they are designed, and the precision with which they have been manufactured. In these respects they are superior to anything before accomplished in this country. Several specimens of a different kind have been exhibited from France and other parts of the Continent; but they are not the best examples of the industry of those countries, excepting some small engines from Sweden, and a beautiful double-acting engine for river boats, by Messrs. Escher & Co., of Zurich. As a whole, the marine department has been well represented by engines of great power, and working models (chiefly by Maudsley & Field) of great beauty.

If our limited space permitted, we might have gone more into detail, showing the various contrivances of the working parts; under the circumstances, we must confine ourselves to the following outlines of the different types of marine engines, as exhibited by the different makers, showing the space they occupy in the ship, length of cranks, &c., as per sketch, taken from Mr. Mallet's report in the *Practical Mechanics' Journal.*



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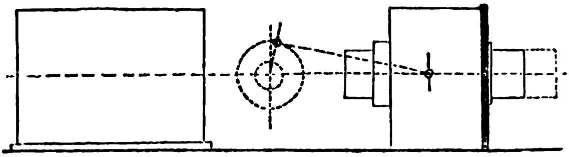

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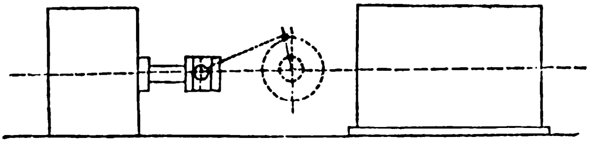
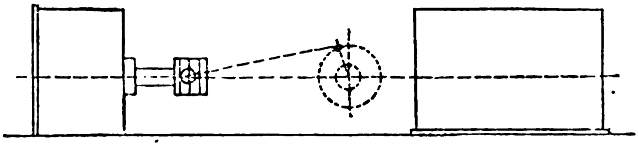


No. 3.



No. 4.

From the above it will be seen that No. 1, with the double piston-rod and reversed connecting-rod, occupies the least space in length; No. 3, with a three-crank connecting-rod, the next; and subsequently follows No. 2, trunk engine, in the order of length; and, lastly, No. 4. Mr. Mallet classes them differently by taking the crank as the unit of measure; from which it follows, that the direct-acting engine, with short connecting-rod, occupies a much less total length than either of the others. This saving of space on board ship is always a desideratum in the construction of marine engines, and is a point carefully attended to in the British navy.

Most of the engines are of the screw-propeller kind, and the specimens exhibited are certainly of the highest order, whether as regards design or workmanship. The working parts are chiefly composed of wrought iron with a link-motion for working the valves. Paddle-wheel engines are not exhibited, excepting only in models, and a pair of oscillating engines, including drawings and models of Maudsley's annular cylinder engine. Most of these have been in use for years, and are, therefore, deficient in novelty when compared with the more compact form of the screw-propeller class. Altogether the Exhibition in this department is replete with admirable specimens of marine constructions, and we have only to instance the 600 nominal horse-power engines by Penn, and the 800 horse-power by Maudsley & Field for the iron-plated frigate *Valiant*, with others of less power, to be assured of the wonderful development of mechanical science in this age of progress.

To marine constructions we have to add a great variety of vertical, horizontal, and angular engines, adapted to almost every possible purpose where power is required. Some of these engines have double, high, and low pressure cylinders, with and without condensers; others are single cylinders of peculiar construction, and exhibit several new arrangements accompanied with surface-condensation * and other contrivances for superheating steam † and preventing the escape of heat. All these are improvements on the past; but those which have been effected during the last seventy years (although valuable in themselves) are not such as affect the general principle arrived at by Watt, and subsequently perfected by the same comprehensive intellect that made the steam-engine what it now is, the strong arm of power and the hard-working agent of civilized existence.

Water-Power.—Half a century has scarcely elapsed since water was the prime agent as a motive force. To that element, and to wind, we had recourse when power was required for the purposes of mining, agriculture, or manufacture; but the limitation of supply and requisite height of fall required for power were so great, and so uncertain, as to cause frequent stoppages of the works, and to spread them widely distant from each other over the face of the country. At the commencement of the present century, when the improved machinery of Arkwright and Crompton created a demand for power on a large scale, the whole of the river and mountain districts were searched for suitable sites for mills; and for a series of years it was found necessary to take the mill to the power and not the power to the mill, as it has been since the introduction of steam. In some countries it is still desirable to employ water as a moving power, and hence follow the numerous improvements that have taken place in the construction of water-wheels, turbines, and other hydraulic machines. As late as 1830 water-power was still in demand in this country; but from that time to the present it has been considered of little value unless it be in some districts where the power is considerable and where the weirs, aqueducts, and mill dams already exist. For a number of years the mills for cotton, corn, and flax were turned by water, and the construction of water-wheels was greatly improved by making them entirely of iron, which took place at the beginning of the present century. The late Mr. T. C. Hewes was one of the earliest improvers of water-wheels on the suspension principle, and this was followed by a new system of ventilation, by which the buckets were relieved of air on the entrance of the water, and subsequently restored at the lowest point of discharge. By this ingenious but simple contrivance the duty of the water-wheel was raised to a maximum, and the construction of water-wheels composed of iron arrived at a very perfect state. It was at this time that the investigations of Poncelet and the perseverance of Fourneyron introduced the horizontal wheel, founded on principles established by the former and adopted, after careful experiments, in the shape of the turbine by the latter. For several years the turbine made slow progress, as its advantages were not superior to that of the water-wheel, which maintained and still retains its reputation in regard to the amount of work done with a given quantity of water. The turbine, however, occupied less space, was somewhat cheaper in its original cost, and became general on the Continent and America. Of late years the turbine has been greatly improved in this country, and we have several admirable specimens in the Exhibition, a few of which it will be proper to notice.

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* Surface-condensation is a vessel where the steam is condensed by pumping cold water on to the exterior surfaces of tubes through which the steam passes.

† Steam is superheated by passing the pipes containing the steam through flues [illegible] ir at a high temperature.

In every description of machine recipient of water it is a universal condition that the water, to attain its full efficiency, should make its entrance and take its departure at a slow velocity. This has never been done with the turbine, but a close approximation has been attained by the best-constructed water-wheel. Smeaton, in his experiments on water-wheels, attained something above 80 per cent. of the theoretical fall, and some of the best wheels of the present time have arrived close upon that point of efficiency. Now, the best-constructed turbines seldom exceed from 65 to 70 per cent. There are, however, certain advantages peculiar to the turbine which do not belong to the water-wheel; namely, that it can be made to work waterfalls of from 300 to 400 feet in height; and what is of considerable importance as regards efficiency is, that it works well in back-water.

There are three different descriptions of turbines.

1st. Turbines in which the water passes vertically through the wheel.

Wheels of this class are composed of two annular cylinders, the upper fixed and the lower revolving on a vertical axis. The upper is fitted with guides to direct the water most efficiently against similarly curved vanes or buckets, turned in the opposite direction, in the lower wheel. The water passes from the reservoir or cistern, placed over the upper cylinder, vertically downwards, acting on the revolving wheel by pressure as it glides over the surface of the vanes. Burdin, about 1826, invented a turbine of this description (*turbine à évacuation alternative*), the efficiency of which was about 67 per cent. of the theoretical fall.

2nd. Turbines in which the water flows horizontally and outwards.

In turbines of this class the revolving wheel is placed outside of the fixed wheel, so that the water directed by guide-plates on the inner wheel strikes the curved vanes of the outer wheel, and forces them round by pressure and reaction. The water is regulated by a cylindrical sluice fitting between the fixed and movable wheels.

M. Fourneyron's turbine is the chief example of this class. Its advantages, as stated by M. Poncelet in his report to the Academy of Sciences at Paris, are the high velocity at which it may be worked without reducing its useful effect, its small size, and lastly, its capability of working equally well under back-water. From the experiments of M. Morin, the coefficient of useful effect * appears to range from 0·60 to 0·80. On the other hand, it has to the full the defects of this class of machines, requiring the utmost nicety of design and execution, and being very susceptible of injury from small bodies carried into it by the water. It requires for its successful application both a large acquaintance with the principles of its construction and a considerable experience of its use.

3rd. Turbines in which the water flows horizontally inwards; vortex wheels.

We owe the invention of this class of turbines to Professor James Thompson, C.E., of Belfast, and probably no turbines are more efficient or capable of more general application to every variety of fall than the vortex wheels which he has constructed.

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* The coefficient of useful effect is the per-centage of the power expended mplished.

The peculiarity of these vortex wheels consists in the arrangement of the fixed guide-blades on the outside of a circular chamber, in which is placed the revolving wheel, so that the water flowing inwards strikes the curved plates of the revolving wheel tangentially, and leaves the wheel at the centre at a minimum velocity; the whirlpool created in the wheel-chamber giving to this description of turbine its designation of vortex wheel. These wheels are constructed by Messrs. Williamson & Brothers, of Kendal, who, we believe, have at present erected all that are employed in this country.

In addition to the horizontal wheel or turbine, there are centrifugal pumps and water-pressure engines. The first and most important is by Mr. Appold, and to that gentleman the country is indebted for many ingenious mechanical contrivances. Messrs. Gwyne have also contributed to the centrifugal pumping system, and both have splendid specimens of their different constructions at the Exhibition. The principle on which this machine is based, is a small wheel, which is driven at a great velocity,—as many as from 800 to 1,000 revolutions per minute, at the bottom of the suction-pipe. This wheel or fanner with blades is driven by a steam-engine, and, revolving at great speed in a tight box, forms a vacuum in the suction-pipe and forces the water before it, up the discharge-pipes to the required elevation.

These machines are simple and effective where the water has not to be raised to a great height, but they are inapplicable for high lifts, and require a considerable amount of power to overcome the friction and pressure of water in the pipes. It is a question yet to be solved as to whether they are equal, on the score of economy, to the common pump. In fact, they are the same as a scoop wheel surrounded by water in a close box.

Those who have witnessed the imposing effect of these machines at work in the Exhibition, cannot be otherwise than struck with the large body of water which they discharge at a height of 12 to 15 feet, and without entering into comparison as to cost or the force employed to raise a given quantity of water, we nevertheless arrive at the conclusion that this system of raising water is well entitled to consideration.

The water-pressure engine, exhibited only in models and drawings, is employed for the same purpose as the centrifugal pump. Steam-power is not used in this case, but is obtained from the pressure of a column of water, which, acting upon a plunger, generates a reciprocating instead of a rotatory motion.

Engines of this description have been long employed in the mining districts of this country and the Continent. Professor Rankine states, that for the most successful application of these engines, as regards efficiency, it is necessary that the motion of the water should be slow, and as far as possible without shock. Three to six strokes per minute, or a velocity for the piston of one foot per second, is about the ordinary speed. The stroke also should be long, and therefore "the most advantageous use to which a water-pressure engine can be put is the pumping of water, to which slow motion and a long stroke are well adapted, because they are favourable to efficiency, not only in the engine, but in the pump which it works."

Grinding, Crushing, and Cutting Machines.—The Exhibition has been fruitful in this department of machinery, some of them being exceedingly well constructed, and entitled to every commendation for the high finish bestowed upon them. Of late years corn-mills have been greatly improved, and the system of arranging the millstones in a line along one side of the mill, and rendering the whole of the processes self-acting by an improved system of cleaning, brushing, and separating the grain with elevators, Archimedian screw creepers, and an improved process of wire and silk dressing, give a degree of perfection to the manufacture that could not be attained when the grinding machinery was less perfect. Several small mills, chiefly on the French system of driving the stones with belts, are exhibited; and others with high-pressure horizontal engines, driving from two to four pairs of stones, are entitled to notice for convenient arrangement and the superior finish of the workmanship.

Several examples of machinery for the colonies are exhibited from Liverpool and Glasgow, and most of these are of a class calculated to meet all the requirements of complete trains of sugar-machinery; as comprised in the steam-engine, rolls for crushing the sugar-canes, evaporating-pans, and centrifugal machines. In this description of machinery there is no particular novelty or improvement, excepting only the steam-engine, which of late has undergone some change in rendering the whole apparatus more portable and convenient for exportation. In oil and powder mills the examples were not striking at the Exhibition, if we except the grinding and compressing apparatus of Messrs. Samuelson & Co., of Hull. That firm exhibited a complete set of hydraulic pumps and pipes, for extracting the oil from the seed inclosed in canvas bags. They also exhibited a pair of edge-stones in motion, which created considerable interest as a point of attraction to visitors during the exhibition.

The Machinery for the Manufacture of Textile Fabrics comprises the largest class of ingenious machinery and clever contrivances ever submitted to public inspection; and these may be divided into machinery for the manufacture of cotton, for flax, and for wool, including stranding and rope machinery of every description. The length of this article, and our limited space, will prevent us from noticing in detail the numerous machines now in use in the different processes of manufacture, from the raw material to the finished article ready for the market. In cotton alone we have no less than from twelve to fifteen preparatory machines, in as many distinct processes, before the article is converted from the cotton into cloth; and these are distinguished as machines for opening, blowing, carding, drawing, slubbing, roving, spinning, winding, wooping, dressing, and weaving, exclusive of other subordinate processes. In all these operations may be seen an automaton system of movements, regulated with the same precision and nicety as a timepiece. It appears almost fabulous, the amount of work done and of power expended in this department of manufacture alone, and the number of hands employed, not as prime movers, but as "tenters" feeding the machines, *unhappily no longer in daily use, for the production of this colossal manufacture.* Many of our readers may not be acquainted with the magnitude of this important branch of national industry; but we may venture roughly to state, that the annual value of this manufacture is upwards of £70,000,000 per annum, and gives employment to nearly one million of persons, or, with its dependencies, upwards of two millions.

The cotton machinery is well represented in this year's Exhibition, by Messrs. Platt, Hetherington, Dobson, and others; and the adaptation, style, and character of the machinery are of the first order, and do the mechanical genius of this country great credit. All the minutiæ of construction appear to be attended to, and the utmost care observed, so that all the preparatory processes are performed by the machines, with a degree of exactitude far exceeding that of the human hand. Of late years a most ingenious machine has been introduced from Alsace, in France, as a substitute for carding. It is a combing machine, and its operations are so exact, and its work so perfect, as to enable the spinner to produce a finer description of yarn from an inferior quality of cotton. This machine is available for the finer numbers of yarn, and is one of the most important inventions since the days of Arkwright and Crompton. It has undergone great improvements since its introduction into this country, and is now extensively employed in the preparatory processes for flax and wool, as well as cotton.

The power-loom combines within itself many important improvements in twills and figure-weaving. The revolving shuttle-box, and the changes that may be effected in colour and form, cause a close run between it and the Jacquard; and many of the beautiful fabrics in cotton, wool, alpacas, and mixed goods, are woven by these looms, and that with a degree of despatch equivalent to nearly forty yards of cloth per loom per diem. To this department of machinery the contributions have been large and successful, and pattern looms from almost every district distinguished for a particular manufacture have been exhibited.

The same degree of progress is observable in flax machinery as in cotton; and the screw-gill machinery first introduced by the late Sir Peter Fairbairn is strikingly exemplified in the Exhibition. A whole train of this machinery, consisting of heckling, carding, roving, and spinning, is exhibited by different makers; and judging from the superior workmanship and adaptation of the machines to the various processes, we should infer, that in flax the same progressive improvement exists as in that of cotton or any other description of manufacture. The same may be said of the long wool, alpaca, and mohair manufacture; but it is much to be regretted that samples from the great works of Saltaire have not been exhibited. The Exhibition has not been well represented in short-wool machinery; but several specimens from Leeds and the West of England are to be seen, exhibiting improvements on the old system of manufacture. From Belgium there are, however, some very good machines, together with several ingenious contrivances for the preparatory process, and for the ultimate finish given to the cloth. In the manufacture of woollen cloth, the Belgians are not behind, if they are not in advance of the manufacturers of this country.

Locomotive Machinery and Railway Plant.—Of all the changes effected by steam, that of locomotive travelling on a road of iron is the most wonderful, and this country has reason to be proud that it has cradled and nursed this Herculean machine from infancy to maturity. It is not the invention of one individual, but the labour of many; and none have done more for insuring its efficiency than the two Stephensons, father and son; not that the late George Stephenson had any extraordinary inventive powers, but he possessed a keen sense of observation, and an indomitable perseverance in every pursuit in which he was engaged; and hence followed his great success as a railway engineer. It is curious to trace the early beginnings and history of this machine from the time of Trevethick and Blenkinsop (as given by Mr. Smiles in his interesting work, "The Lives of the Engineers"), to its final completion in its present high state of perfection. As a steam-engine, there is nothing new or striking in its form or construction; its power and success depend almost entirely on the boiler as a generator and a never-failing source of supply of steam. To this small vessel, 11 feet long and 3 feet 10 inches in diameter, with a square fire-box at the end, we are indebted for the almost incredible performances which we daily witness on every line in the kingdom. Few of our readers are probably acquainted with the simple yet effective contrivances by which this comparatively small vessel exercises such enormous power over a dead weight of two hundred tons, which it hurls along on its iron course with a velocity far exceeding that of the swiftest race-horse. This is the work of a machine mounted on six wheels, and contains within itself, at a pressure of 150 lb. per square inch, a force of 7,000 tons bottled up ready for use. A tithe of that force could not be generated in the same space but for two causes; namely, the large heating surface exposed to the action of the furnace, and the blast from the cylinders into the chimney. It is to the first, as the recipient of heat, and to the second, creating a draught through the furnace, that this enormous force is due. To the philosopher and engineer these principles are familiar; but to those who have not examined the parts, and made themselves acquainted with the principles on which they are based, they must ever remain an enigma.

It will not be necessary in this place to point out and describe the uses of the different organisms of this very tractable and powerful machine; suffice it to observe, that in so far as regards simplicity of design, quality of material, and sound construction, the English engineer is in advance of all his competitors; yet certainly not so far ahead but that he may be overtaken and distanced in the race, unless he maintains his position as a leader and trainer in the mechanical sciences and constructive art. It must be acknowledged, in justice to our foreign neighbours in France and Germany, that their engines are not only well made, but they combine several ingenious contrivances for the ascent of steep gradients, and the safe working of tortuous lines in mountainous districts. The only fault that can be urged against the foreign engine is the complexity of its parts, and a want of that simplicity of form which distinguishes the English construction.

In the locomotive department there is nothing new to record, excepting that the engines and tenders, as a whole, are superior in power and construction to those which were exhibited in Hyde Park in 1851, and at Paris in 1855. We must not, however, lose sight of Giffard's injector, for supplying the boiler with water; and a novel invention by Mr. Ramsbottom, the engineer and locomotive superintendent of the London and

North-Western Railway, for supplying the tender with water when the engine is running. This ingenious apparatus consists of a dip-pipe or scoop attached to the bottom of the tender, with its lower end curved forwards, and dipping into the water contained in an open trough, lying longitudinally between the rails at about the rail level, so as to scoop up the water and deliver it into the tender-tank while running. The speed in practice at which water is picked up varies from a minimum of twenty-two miles per hour.

By means of this apparatus, the size and dead weight of tenders for running a given distance are reduced, as also the time required on the journey. It has been in use on the Holyhead line since October, 1860, and since that time, about 2,250,000 gallons have been picked up. Another trough has lately been laid down on the Liverpool and Manchester line, and a third near Wolverton—the last being intended for the use of the fast trains which run between London and Rugby, a distance of eighty-two miles, without stopping. The picking-up apparatus was illustrated in the Exhibition by a working model. An engine, similar to that exhibited, has run from Holyhead to Stafford, a distance of 131 miles, without stopping, in 144 minutes: being at the average rate of 54½ miles an hour. An engine of the same class lately brought the mail train from Holyhead to London, a distance of 264 miles, being the greatest continuous run ever made by one engine. The average speed was 42 miles an hour.*

The Machinery of Agriculture imports a new era in the history of mechanical science, and in this uncertain and precarious climate it is a desideratum that we should have the means, not only of preparing the soil, but we should avail ourselves of every favourable opportunity for gathering in the crops, and housing them with safety in wet weather. In tracing the history of our agricultural improvements, it will be found that they originated with a few distinguished men in the south-eastern parts of Scotland, and with the father of English farming, Arthur Young, the great breeder, and the most talented of English farmers. To these men we owe the first movement in agricultural improvements, and from their time up to the present there has been steady progress. It would not be too much to say that the produce of the soil of this country has been trebled within the last century, and the quantity of land reclaimed from sterility, and the improvement of that previously cultivated has been such as to excite the wonder of the past, and to stimulate the exertions of the present generation. Even as late as the beginning of the present century, although much had been done in draining, accompanied with the new system of rotation of crops, comparatively little had been accomplished in the shape of machinery as applied to the labours of the farm. The south of Scotland took the lead in a superior class of implements for tillage, and the thrashing-machine, driven by water and horses, was introduced about the same time by Andrew Mickle, of East Lothian; but steam as a substitute for animal power had never been thought of, and until the last ten or fifteen years the great steam arm of science remained a listless agent, inoperative in the hands of the agriculturist.

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* *Vide* "Practical Mechanics' Journal," p. 272.

At the present day, the very reverse is the case: as steam-engines, steam-ploughs, and other steam drudges of the farm, are not only appreciated, but they testify their value by their presence at the Exhibition.

In this display we recognize one of the most imposing sights in the world's fair, and it is not too much to say that the agricultural mechanician has equally distinguished himself for solidity of construction, simplicity of details, and economy in price, with his contemporaries, the marine and locomotive engineers. The steam-ploughs of Fowler, and the engines and machinery of Ransome & Clayton, may challenge competition in any department of mechanical science, and the implements generally in this important division are exceedingly well made and admirably designed for the purposes for which they are intended.

Reaping-machines of almost every description are well represented at the Exhibition, and there appears to be no end of cultivators, grubbers, and sub-soilers, all of which are carefully designed and well made. In the construction of reaping-machines, considerable improvements have been from time to time effected by Smith, Bell, McCormack, and Crosskill; but the labours of the engineer are of little value, unless supported by the agriculturist in the preparation of the land, so as to render it available for the work of the machine. To make a reaping-machine work well, *everything* must not be left to it; the farmer has his duty to perform in preparing the land as well, as the machine, and that being carefully accomplished, the great problem of machine labour will soon be solved, and the farmer may then calculate with certainty upon securing his crops in the worst of seasons. In a variable climate, such as that of England, where a whole harvest may be lost or seriously damaged unless rapidly cut and securely housed, the machine reaper becomes invaluable, and cannot fail, when properly constructed and applied, to become the farmer's friend, and a great national benefit.

Miscellaneous Articles and Machines.—Our limited space will not permit us to enter into detail, or we should have noticed a considerable number of machines and objects well entitled to consideration: we may, however, remark that amongst them is a splendid collection of tools of varied forms of construction; such as lathes and machines for boring, planing, grooving, and slotting, including steam-hammers, riveting, punching, and wood-cutting machines of every description. All these are well and ably represented by the first makers, and for these as well as for the paper and letter-printing-machine makers, too much cannot be said; the ingenuity and skill with which these valuable and important machines have been produced surpass all description.

If we examine the state of society as it now exists, in comparison with what it was nearly a century ago, and observe the amount of work then done by manual labour without the assistance of machinery and the steam-engine, it will be found that the labour of one individual in those days was not more than one hundredth part of what it is at present; and this immense increase of work does not arise from any increase in the muscular strength of man, but from his having called to his aid that all-powerful and never-failing agent steam, and the beautiful organisms to which its power is applied.

We might instance innumerable examples by which the ingenuity of man has, by appliances and the adaptation of machinery, turned to account the natural products of the earth to supply his wants, and contribute to the social comforts of his existence. In the manufacture of cotton, one man will spin one thousand times more yarn than could have been done before the introduction of the steam-engine and machinery; and in the manufacture of iron, the work of one individual with the aid of the rolling-mill, is increased nearly in the same proportion. Other manufacturing processes have undergone the same beneficial changes, and we have reason to hope, from the exertions of an intelligent and well-conducted population, that the advantages thus gained will be preserved and increased throughout future generations.

Having thus glanced, however imperfectly, at some of the leading objects in the machinery department of the great International Exhibition recently closed, we may safely state in conclusion, that more splendid and more instructive examples of the useful arts were never at any previous time brought under the inspection of the public. There is no department of practical science which has remained unrepresented, and the student, mechanic, or engineer, had only to read in his own department of study the great page of nature and art which, at this Exhibition, was laid open for his perusal. It is a great privilege for the present generation to have had before their eyes the finest specimens of the manufacturing machines in operation in their day, and in the construction of which it is their ambition to excel. This is an advantage of which few countries can boast, and it is of a character that will leave its impress upon the public mind, and will raise the thinking and industrial portion of the community of this and of all other nations much higher in the scale of civilization.

No. VI.

THE IMPLEMENTS OF WAR.

BY CAPTAIN J. F. D. DONNELLY, R.E.

(INSPECTOR OF SCIENCE, SOUTH KENSINGTON.)

IN comparing the Exhibition of 1862 with that of 1851, it must have struck all observers that in nothing was there greater change—advance—improvement if you will—than in the implements of war. In no other department could there be a question whether or not such improvement was a subject of congratulation. Is it so here? An interesting inquiry no doubt, but wholly beside the object of our article. We can but note the fact. The causes are obvious. In 1851, Europe had, for five-and-thirty years, enjoyed, comparatively speaking, a profound peace. Since then, two European wars, a protracted struggle in America, and a general feeling of uneasiness that a third war may break out in Europe at any moment, have directed universal attention to the subject.

The effect of this attention has been very marked; whereas in 1851, with the exception of a few military men and sportsmen, no one took the slightest interest in improvements in rifles and such instruments, for the last few years there is scarcely a schemer with an idea, and a belief in his own ingenuity, who has not come forward with his inventions; scarcely a firm of mechanical engineers which has not dabbled in patents for guns, armour-plates, forts, and so on. People who had perhaps never heard of a rifle, and certainly did not know the precise difference between that and a smooth bore, are now well up in the latest performances of "Whitworths" and "Armstrongs" (which the daily papers publish in their most prominent columns), and are ready to give a decided opinion on their respective merits. This is enough to account for the great stride which has been made during the last ten years. To note all the instances of improvement, and to describe them, would require a much greater space than that at our disposal. A consideration of the principles involved in these changes, which is all that we can attempt, may, however, be of interest.

The substitution of the rifled bore, with the elongated projectile, for the smooth or plane cylindrical bore with the spherical bullet, may be regarded as the main element. And yet the invention of the rifle and elongated shot was not new even in 1851. To take one instance, Captain Norton had for some twenty or thirty years, and others for a longer or shorter period, been advocating elongated and expanding projectiles, which are now universally adopted for the small-arms of every European army, without receiving the least encouragement. This is one of the many examples of inventions, which, coming before the world was ready for, or required them, have fallen still-born. Indeed, the mathematician Benjamin Robins, who may almost be considered the father of modern gunnery, as far back as 1747, published a short work explaining the true use of the spiral grooves of the rifle and their great value in insuring accuracy, and suggested how advantage might be taken of them to enable us to employ elongated (egg-shaped) projectiles which would give increased range and accuracy. He concludes with the following remarkable prediction:—

> I shall, therefore, close this paper with predicting that whatever state shall thoroughly comprehend the nature and advantage of rifled-barrel pieces, and, having facilitated and completed their construction, shall introduce into their armies their general use with a dexterity in the management of them, they will, by this means, acquire a superiority, which will almost equal anything that has been done at any time by the particular excellence of any one kind of arms, and will perhaps fall but little short of the wonderful effects which histories relate to have been formerly produced by the first inventors of fire-arms.

His advice was neglected for a hundred years. Might we not with safety refer to the Austrians at Solferino, and the Chinamen of the Taku forts, for confirmation of the truth of his prophecy? It appears as if the strong impulse which is necessary to force on a change had never till lately been called into action; though, at the same time, in the case of large guns — heavy ordnance — another cause must be allowed to have exercised a certain amount of weight. Without the means afforded by the steam-hammer and other modern mechanical and manipulative contrivances, it would be impossible to construct such guns as those of Sir W. Armstrong or Mr. Whitworth, or their ammunition. This, however, does not apply to the more simple constructions followed on the Continent, and which might have been as effectively employed fifty years ago.

We will now attempt, though necessarily in a very superficial manner, to elucidate the reasons for a rifle being a more accurate and far-reaching weapon than the old smooth bore; for without some knowledge of these, the changes can scarcely be appreciated. Neglecting the form of the outside at present, let us consider the interior only, and following the Irishman's receipt for making a gun, as the first stage, "take a long hollow," and we have the long cylindrical bore, closed at one end, in which the charge of powder is ignited, and which, becoming very rapidly, though not instantaneously, converted into gas, drives the projectile—a spherical bullet—before it in one direction, and the gun in the other.* Unless the gun be a breech-loader, the bullet must necessarily, for ease in loading, be rather smaller than the bore. Through this interstice, termed *windage*, a great deal of the gas escapes uselessly; whence there is a great loss of initial velocity. And further, the bullet goes bounding along the bore, striking first against one side and then the other, and leaves it, not in the direction of the axis of the piece, but in some other direction, depending on the side it struck last, which is one cause of inaccuracy; but it also, either from having rubbed against one side of the bore more than the other, or from its not being perfectly homogeneous,—when the centres of figure and gravity do not coincide,—carries with it a spinning or whirling motion, which is another and more important cause of inaccuracy. For this rotation causes great deflection, in the following manner:—Owing to its rapid motion, the air becomes more condensed in front of the bullet than behind; in fact, when the velocity is more than 1,344 feet per second (the rate at which air will rush into a vacuum), there is a complete vacuum behind it. If we imagine the bullet to combine with its motion of translation, a rotation from left to right as we look down upon it while facing in the direction in which it is going; that is, representing the bullet in plan by a shilling, in the direction that the superscription runs; then the air being denser before than behind, there will constantly be a greater friction on the anterior than on the posterior half of the bullet,—a friction that is opposing the motion of rotation of the front half to the right, and therefore tending to deflect or make the shot roll off to the left. But at the same time one half—supposing the bullet to be cut in two, in the opposite direction, by the plane of the trajectory—is moving in the same direction with, and the other half against, the motion of translation. That is, in the case just considered, the left half would be rotating in the same direction as the motion of translation, the right half in the opposite direction; consequently, the motion of the right half would be assisting, and the motion of the left retarding, the air in escaping past it. The bullet, therefore, constantly creating and meeting a denser medium on the left than on the right, has a tendency to deflect to the right. This tendency, which is in the opposite direction, is stronger than the one before mentioned, and the ball is deflected to the right—in a curve, as the velocity of rotation diminishes less rapidly than the velocity of translation.* In the same way the range is increased or diminished according as the rotation of the fore part is upwards or downwards.

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* The *permanent* gases generated occupy, it is computed, at the temperature supposed to be produced—3,000° Fahr.,—a volume of about 2,000 times the bulk of the powder. But this point, as well as whether, at this high temperature, Marriott's law of the elasticity varying as the density holds good, has never been accurately determined. If, however, we take Dr. Hutton's estimate, which is rather a low one, that the first force of fired gunpowder is equal to 2,000 atmospheres (30,000 lb.) on the square inch, and that, as Robins computed, the velocity of expansion is about 7,000 feet per second, we have some idea of the force.

From these remarks may be gathered the general causes which give uncertainty to the direction of the flight of a spherical ball from the smooth-bored gun; viz., uncertain rotation and the resistance of the air. In the rifle we have a means of counteracting these by imparting a constant and fixed rotation. The rifled barrel, instead of being a plain cylinder, has spiral grooves cut in it. The ball fits these grooves, and in being forced out by the powder, is constrained, in the same way as a screw in being withdrawn from a nut, to rotate round an axis which is the same as that of the bore of the gun. This rotation is constant, and the tendency is for the axis of a rotating body to remain parallel to its original direction,† as may be easily seen with a spinning-top; and, moreover, the axis being coincident—at all events, during the early part of the flight—with the line of the trajectory, the causes of deflection before considered do not come into play, while, at the same time, any irregularities of surface are brought first to one side and then to the other; and any deflections which might be caused by them are neutralized.

Having now shown how the inaccuracy is overcome, let us examine how the range is increased. The obstacle to an increase of range is the resistance of the air, which, with high velocities, is very great, as may be gathered from the following experimental resistances to a ball two inches in diameter, extracted from a table given by Dr. Hutton. With a velocity of 100 feet per second, it was ·174 lb.; with 200 feet, ·709 lb.; with 900 feet, 94·106 lb.; and with 2,000 feet, 102·362 lb. As the resistance is nearly proportional to the surface exposed to it, so, to gain increased ranges, it is necessary to increase the weight of the ball in a greater ratio than the surface exposed. For if two balls, one twice the weight of the other, exposing the same surface to the resistance of the air, are projected with the same velocities, the heavier having twice the momentum or store of motion, has twice the power of overcoming the resistance; that is, twice the range. With smoothbored guns and spherical shot, the only way of accomplishing this (increased density being practically out of the question), is to increase the diameter of the shot, when the weight increasing as the cube, and the surface as the square of the diameter, the desired result is obtained, as far as the other circumstances will admit.

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* Robins showed this very well by an experiment with a bent musket-barrel; the ball, instead of following the direction to which the end of the barrel was bent, was incurvated in the opposite direction, and crossed the direction of the straight portion. The ball, in fact, rubbing against the bent portion, received a strong rotation in the opposite direction, and, as explained, was deflected.

† See Mechanical Summary, p. 277,—"Guns and Iron-cased Ships,"—a of projectile.

With high velocities (as was shown by Dr. Hutton), the resistance rapidly rises in a variable ratio, which increases more and more above the square of the velocity; so that, beyond a certain point, the increase is of no avail.

In the rifle, however, the power of impressing a rotation gives us an advantage in overcoming the resistance of the air. For, as the tendency is for the axis of a rotating body to remain parallel to its original direction, if we project an elongated shot, it will be maintained with its point foremost during the flight, and, in proportion to its weight, will present a very small surface to the resistance of the air. Thus, if we compare Mr. Whitworth's 3-pounder with the old 3-pounder, the weights of the shot are the same, but the diameter of the spherical shot is 2·91 inches, and of the Whitworth 1·5 inch; the surfaces are, therefore, as 8·47 to 2·25; that is, the Whitworth, with an exposed surface of only about one-fourth that of the 3-pounder, has the same weight wherewith to overcome the resistance offered by the atmosphere. Hence the enormous range that was obtained,—9,688 yards, or upwards of 5½ miles. It must not, however, be inferred from this that the projectile may be indefinitely increased in length, and increased ranges thereby obtained. For as the powder is by no means instantaneously converted into gas, we very soon arrive at a limit beyond which it is useless to increase the charge; for it would not be wholly exploded before the shot left the gun, and we arrive at a point where the velocity is decreased without any corresponding gain. It is perhaps right to notice here the erroneous idea, that an elongated rifle projectile has a much greater initial velocity than a round shot. A little consideration will show that this is not the case. With the same pressures acting through the same spaces, that is, similar charges fired under like conditions, the velocities of the shot will be inversely as the square roots of their weights. Besides which, in the case of the rifle, there is the work lost in friction and in giving the rotation. Where the rifle does gain, is in this; that whereas, *cæteris paribus*, the initial velocities are inversely as the squares of the weights, the resistances of the air rise in a much higher proportion than the squares of the velocities, when these are high. A limit is, therefore, reached beyond which it is useless to increase the velocity of the round shot, and which it is possible nearly to attain with the rifle projectile. The following table, extracted from the "Lectures on Artillery," by Major Owen, R.A., and Captain Dames, R.A., at the Royal Military Academy (from which work we also, by their kind permission, copy the drawings of the gun and fuzes), will illustrate these remarks, showing, as it does, that at first the higher velocity of the 12-pounder round shot gives it the advantage over the Armstrong.

	RANGES AT ELEVATIONS OF—					
	Point Blank.	1°	2°	3°	4°	5°
12-pounder Armstrong, weight 6 cwt., charge 1 lb. 6 oz....................	300	600	900	1,200	1,500	1,600
12-pounder (service), weight 18 cwt., charge 4 lb.........................	300	700	1,000	1,200	1,400	1,600

This table, moreover, does not fully *express* the difference in initial velocities of the two shot; for, paradoxical as it may appear, the ranges of the elongated projectile are, up to about 6° of elevation, absolutely greater in the resisting atmosphere than they would be *in vacuo;* for the elongated shot, from its rotation, retains the same inclination to the horizontal plane throughout the flight, and consequently acquires a continually increasing obliquity to the curve of its flight. And the effect of this obliquity is, that the projectile is in a measure sustained upon the air, just as a kite is supported by the current of air meeting the inclined surface; and its descent being retarded, it has time to reach a greater distance. At least this is Sir W. Armstrong's explanation, and there is no doubt that whereas the 12-pounder with an initial velocity of about 1,600 feet per second, does not, at 2° of elevation, attain two-thirds of the range it would have *in vacuo*, the Armstrong, with an initial velocity of about 1,050 feet per second, exceeds it by about 120 yards.

From the above-mentioned obliquity of the elongated projectile to the curve of its flight, and the consequent unequal action of the resistance of the air above and below, arises a deviation in its flight, which is termed *derivation;* but this is constant for similar ranges, and can be allowed for.

We now come to a practical difficulty in the manufacture of large guns. This difficulty was found even in making round-shot guns of above eight inches in diameter of bore, strong enough to withstand the charge required to impart high velocities to solid shot; and with elongated shot this difficulty is greatly increased, because the weight of the projectile is increased in proportion to the size of the bore. For as was pointed out, we believe, first by Dr. Hutton, it is of no use to increase the thickness of metal in the gun beyond a certain point. Let us take the cross-section of a gun, that is to say, an annulus, and inquire, what is the precise action of the exploded powder on this? We know that iron in resisting a tensile strain is extended (a small portion of the extension, from want of perfect elasticity, being permanent), and the gun, or the portion of it which we are considering,—the annulus, is therefore enlarged, this enlargement being, to a great extent, only momentary. But though it is enlarged, the area of the annulus, which, being the cross section, represents the amount of metal in the gun at that point, must remain the same; therefore the width must diminish; or, which is the same thing, the circumference of the inner circle must be increased in a greater ratio than the outer; *i. e.*, the inside of the gun must be more stretched than the outside. Now, if we consider the annulus divided into its component concentric rings, the greater the distance of each successive ring from the centre, the less will it be stretched, the less will be the strain on it, and the less good will it do,—till we arrive at a point when the inside of the bore or inside ring will be ruptured, before any strain is taken by the outside; so that, beyond a ceertain point, increasing the thickness of the metal is useless.

In order to make the gun sufficiently strong, various means have been suggested (Captain Blakeley, some of whose guns were in the Exhibition, having been, we believe, one of the first and most successful in practically meeting the difficulty), such as shrinking or driving on rings of metal on an inner core, or by winding wire on it with an increasing strain, so that what is called an "initial tension" is given to the outside of the gun; and the successive rings of the annulus in their normal state vary from a state of *compression within* to *tension without;* each part thereby bearing its own work—that is, when the strain comes on it, the whole thickness of the gun is serviceable in resisting it.

We have now to consider the projectile. Windage, or the looseness of the bullet in the bore, for ease in loading, has been before adverted to, with the inaccuracies to which it gives rise. In the rifle, where the spherical bullet was used, there was necessarily no windage, for the bullet, in order to take the grooves, was (except in the two-grooved rifle with belted ball) forced down by a heavy ramrod and mallet. This difficulty in loading was, indeed, one of the main objections to the rifle. Breech-loaders and expanding bullets afford means of avoiding windage and yet loading easily.

The methods by which the modern cylindro-conical projectile is made to take the rifling, or fit the grooves of the gun, may be classed under three heads:—

1. The mechanical fit, where the projectile is made of the exact form of the bore before being inserted in it. The projectile may be of hard metal throughout. This plan has been adopted by Mr. Whitworth, Mr. Lancaster, Captain Blakeley, and others, in England, and in all the foreign ordnance we have seen.

2. By making the projectile (which must, therefore, be at least coated with a soft metal) rather larger than the bore of the gun. It is inserted at the breech, which is enlarged to receive it, and it takes the rifling by being forced forward by the powder and crushed into the grooves. This plan is adopted by Sir William Armstrong,* and also in many breech-loading small-arms.

3. By the projectile, which is of some soft metal, as lead, and is small enough to be loaded at the muzzle, being made to expand into and take the grooves by the explosion of the powder. The projectile, then, generally has a hollow at the base, in which a wooden or iron plug is inserted. This having less specific gravity than the lead, is driven forward by the discharge, and expands the bullet. It is found also, that when the projectile is proportionately rather long, the hollowed base, either with or without a plug, is unnecessary; the expansion takes place sufficiently without it, from the explosion acting in the manner of a blow, and forcing the base of the cylinder forward before the front has had motion communicated to it. This plan, though very generally adopted for small-arms, has never succeeded with ordnance. In small-arms it is very generally

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* Sir W. Armstrong has, however, made some of his large guns muzzle-loaders, on the *shunt* principle, which is of the nature of a mechanical fit.

Whitworth Shot

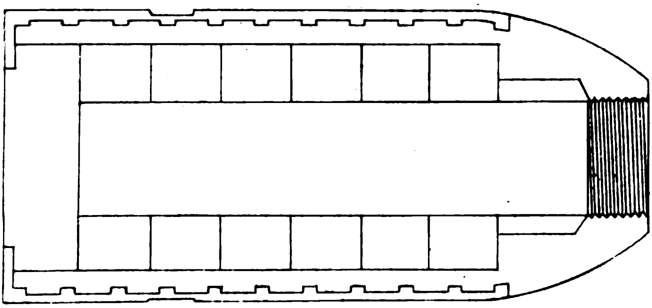
Fig. 5

Whitworth

Fig. 6

Fig. 2

Armstrong Shell



Half Size

Fig. 1

Armstrong

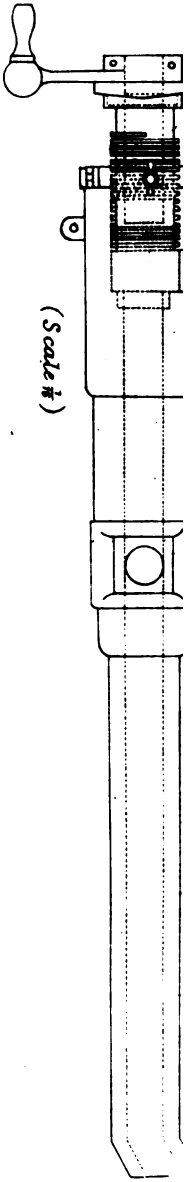


Fig. 3

Armstrong

Time Fuze

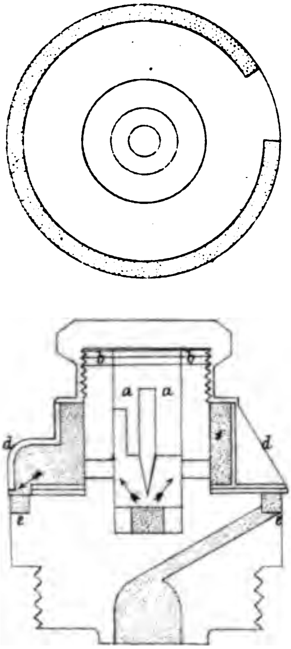
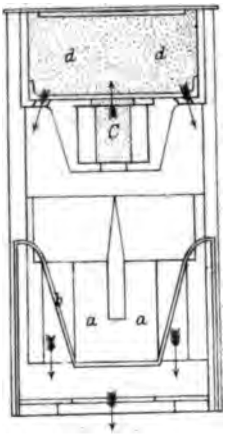


Fig. 4

Armstrong

Concussion Fuze



Full Size

aa. Represents the Striker
bb .... *Suspending Pin*
c .... *Detonating Compⁿ*
dd .... *Hollow Collar*
ee .... *Fuze Composition*

aa. Striker
bb. Suspending Pin
c. Detonating Composition
dd. Priming Chamber

Implements of War

termed the Minié rifle, Captain Minié, of the French army, having, though he was not the inventor, first brought it very prominently forward. Captain Norton was, we believe, the real inventor of the expanding bullet.

Considering the Armstrong and Whitworth rifles as the most elaborate English types of the two systems of rifling, we will, as far as possible, describe them. In Plate VII. will be seen a drawing of the Armstrong gun, of the shell, and the two fuzes, and drawings of the ordinary and flat-headed Whitworth shot. The process of manufacture of the Armstrong gun is so very complicated that it would be impossible without numerous plates to give a description of any value. Suffice it to say, that the guns are made of wrought-iron bars, coiled and then welded together in lengths of about two or three feet. These tubes are then welded together and formed into a long barrel. This constitutes a core, which is strengthened at the breech, where the action of the powder is the greatest, by similarly made cylinders or tubes of wrought iron, which being constructed of such a size that they are too *small* when *cold*, are put on when *expanded by heating*. When these cool and contract, they afford the necessary initial tension. The breech is forged solid, and welded on. The gun is loaded at the breech through the powerful hollow screw, which is shown in the plate. The charge having been inserted, the vent-piece is dropped into the slot behind it, and tightened up by means of the screw through which the charge was inserted. The vent-piece has a disc of copper on its face, which, by this operation, enters the bore, and by its expansion at the time of explosion prevents any escape of gas. Through the vent in it, the gun is fired. The number of grooves varies in different calibres; in some of the larger ones there being as many as forty. These grooves are very shallow, with one side (the one on which the shot bears while coming out) rectangular, and the other rounded off. The rapidity of twist or pitch of rifling varies from one turn in thirty to one turn in thirty-eight diameters. The bore of the gun, up to a sufficient distance in front of the vent-piece, is smooth and enlarged to form a chamber, into which the shot and charge is pushed by hand.

The following description was given by Sir W. Armstrong, of the projectile—the shell,—in a paper printed by the *Institution of Civil Engineers*; and with some further description is extracted from Major Owen and Captain Dames's lectures:—

The projectile consists of a very thin cast-iron shell, the interior of which is composed of forty-two segment-shaped pieces of cast-iron, built up in layers around a cylindrical cavity in the centre, which contains the bursting charge and the concussion arrangement. The exterior of the shell is thinly coated with lead, which is applied by placing the shell in a mould and pouring melted lead round it.* The lead is allowed to percolate among the segments, so as to fill up the interstices, the central cavity being kept open by the insertion of a steel core. In this state the projectile is so compact that it might be fired through six feet of hard timber without injury, while its resistance to a bursting force from within is so small that less than one ounce of powder is sufficient to break it in pieces.

The segmental pieces act like the voussoirs† of a bridge in fact, in strengthening the shell; but are easily liberated, when they are very destructive. This same projectile can be used as a shell; by leaving out the bursting charge, as a shot; by arranging the fuze so as to burst it as it leaves the muzzle of the gun, as common case; or, lastly, by arranging the fuze to burst it just before reaching the object, as shrapnel. Such simplicity of ammunition, which further enables one gun to fulfil all purposes of gun and howitzer, is of the very greatest advantage. Two descriptions of fuzes are used by Sir W. Armstrong; the one a percussion fuze for use when it is intended to burst the shell on striking an object; the other, a time fuze, to explode it at any given length or time of range, without its striking an object, as when used as case or shrapnel. It must be remembered that the gun is a breech-loader, and that there is no windage by which the gas or flame of the powder can, as with ordinary guns, get round the shot and ignite the fuze. The latter has, therefore, to ignite itself at the instant of discharge. This is effected by a percussion arrangement; the rest of the fuze being very much on Breithaupt's principle. Sir W. Armstrong thus describes his fuze:—

The body of the time fuze (fig. 3) is made of a mixture of lead and tin cast to the required form in a mould. The fuze composition is stamped into a channel forming nearly an entire circle round the body of the fuze, and is afterwards papered and varnished on the external surfaces. As the shell fitted accurately into the gun, there was no passage of flame by which the fuze could be ignited. The effect is, therefore, produced in the following manner:—A small quantity of detonating composition is deposited at the bottom of the cylindrical cavity in the centre of the fuze, and above this was placed a small weight or striker, terminating in a sharp point presented downwards. This striker is secured in its place by a pin, which, when the gun is fired, is broken by means of the *vis inertiæ* of the striker. The detonator is then instantly pierced by the point, and is thus fired. The flame thus produced passes into an annular space formed within the revolving cover, which rests on the upper surface of the fuze composition; and from this annular space it is directed outwards through an opening, so as to impinge on and to ignite the fuze composition at any required part of the circle. The fuze thus ignited burns in both directions, but only takes effect at one extremity, where it communicates with a small magazine of powder in the centre. The fuze is surrounded by a scale-paper, graduated to accord with the elevation of the gun, so that when the range of a distant object is found by trial, it is only necessary to turn the igniting aperture of the cover to the point on the fuze scale corresponding with the degrees and minutes of elevation on the tangent scale.

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* Mr. Bashley Britten's plan of joining the lead to the iron by an interior skin of zinc is, we believe, now adopted.

† The voussoir is the technical name given to the wedge-shaped stones which constitute an arch.

The concussion fuze (fig. 4) is on nearly the same principle. A striker with a point presented upwards is secured in a tube by a wire fastening, which is broken on the firing of the gun; the striker being thus liberated, recedes through a small space, and rests at the bottom of the tube; but, as soon as the shell meets with any check in its motion, the striker runs forward and pierces the detonator in front; by which means the bursting charge is ignited.

The Whitworth gun may be either a breech-loader or a muzzle-loader,—that is to say, some are made to load at the breech; but their construction is such, that if anything in the breech-loading apparatus should go wrong, the gun is not disabled, as with the Armstrong, but can be loaded at the muzzle. The form of the bore can perhaps best be understood by examining the shot of which drawings are given (figs. 5 and 6), and imagining the bore which will fit them. It is in fact in section a hexagon with the angles rounded off. If we imagine this section to move along the bore with a rotation which would make one complete turn while moving along a length of twenty diameters (which is the pitch given in the Illustrated Catalogue of the Exhibition, from which the drawings are taken, for all calibres), it gives the bore. Mr. Whitworth constructs all his guns of homogeneous iron, the smaller calibres being simply bored out of a solid bar, and the larger ones strengthened by wrought-iron hoops forced on by hydraulic pressure. To secure ease in loading, without windage (except to a very small extent), those portions of the sides and angles of the hexagon of the bore on which the shot bears while being rammed down from the muzzle, are eased off slightly. The shot bearing close on the other portions when being driven out by the powder, prevents nearly all waste by windage. The ordinary shot, which is cast, is put into a lathe to be faced to fit the bore, though, on occasion, it may be finished in casting. Mr. Whitworth has found that, by diminishing off the tail of the projectile, as shown, a greatly increased range is obtained. The shot with which the extraordinary penetrations, lately reported in the newspapers, was obtained against iron plates, is of the form shown in fig. 6, flat-headed. Mr. Whitworth's theory is, that the flat-headed shot punches out a portion of metal *clean*, while a great deal of the momentum of the pointed shot is lost in compressing the metal *sideways*, like a wedge, as it penetrates; thereby at each instant creating a greater opposition to its advance. These shot are made of steel or homogeneous iron, or faced with it.

At the late experiments at Shoeburyness, the Whitworth 120-pounder, at a range of 800 yards, sent a flat-headed shell, which, with its bursting charge of 5 lb., weighed 150 lb., through a target consisting of 5-inch iron plates, on a 12-inch teak backing, with a ⅝-inch wrought-iron skin within, the shell bursting inside. The 70-pounder, at a range of 600 yards, sent a shell weighing, with its bursting charge of 3 lb. 12 oz. of powder, 81 lb., through 4½-inch plates, with 18-inch teak backing and a ⅝-inch skin. No fuze is required for these shells, as the passage through the iron plates heats them sufficiently to ignite the powder. In the ordinary Whitworth shell the percussion arrangement is not required in the fuze, as the flame can communicate with it. In the Whitworth breech-loader, the breech is closed by a cap which screws on outside. This cap works in an iron hoop, which is attached by a hinge to the side of the breech. When unscrewed, the cap is by this means opened back like a door, disclosing the bore for the insertion of the shot and cartridge. The vent is in the centre of the cap, in the axis of the gun. The cartridge is contained in a tin or copper case, which prevents any escape of gas. The mouth of the cartridge is closed by a lubricating wad, which lubricates and cleans the bore after each discharge. This wad has also now been adopted with the Armstrong gun, and avoids the necessity of constant sponging out.

These few remarks would scarcely be complete without some comparison between the rival systems. General Morin, in the June number of the *Annales du Conservatoire Impérial des Arts et Métiers*, makes some remarks which appear to be just, though there are some portions of the article in which the able author seems to have been labouring under a misconception. He says that the advantages of the Armstrong projectile are compensated for by numerous defects. The manufacture of the projectiles is very delicate. Their nature is such as to require a care in preservation which the hazards of war render it impossible to afford them. While, on the other hand, after describing the Whitworth system, and commenting on what he considers an excess of nicety and exactness in their manufacture, as shown, which is not by any means indispensable, but may on service be found not only superfluous but inconvenient, —he speaks highly of the Whitworth principle, and says that, niceties are modified so far as experience and the exigencies of service may require, the system is worthy of the highest attention.

War is a rough and rude master, and though we cannot but admire the extraordinary ingenuity and the great mechanical skill brought by Sir W. Armstrong to bear in the construction of his guns, and the perfect contrivance which it is, when we consider the great care required even in preventing corrosion or injury to the bore, we may well doubt, without presumption, whether, though tested in a short campaign in China, from starting on a wrong basis, his ingenuity has not been misdirected, in creating a weapon too delicate for the rough handling and neglect inseparably incident to a protracted European campaign.

Our limits forbid our entering on the description of the numerous other ingenious and original inventions exhibited in the military court; such as Captain Fowkes's admirable collapsing canvas pontoons; Captain Boxer's diaphragm shells and parachute lights; and the various small-arms, &c., which rendered this display so instructive. These will be found described in the jury reports, which we have endeavoured to supplement, to a certain extent, by a popular description of the principles involved.

What will all this lead to? Are armies and navies, like the famed Kilkenny cats, to fight till nothing but their tails are left? Where will it all end? These are complex questions, which must have suggested themselves to many. And yet there is a simple solution which presents itself. In affairs of honour with the small-sword, A's and B's seconds would egregiously fail in their duty if they permitted B to use a rapier an inch longer than A's. All A's swordsmanship would be thrown away, his most scientific attack lost, if, when finally lunging on his antagonist, B had simply straightened his arm. Before A's rapier could reach him, that one extra inch had given B the victory; he had "pinked" A.

If an extra length of sword thus secures the victory, one would infer that, in the days when swords were worn and used, they would all have been of the utmost length consistent with the capability of the wearer to wield them. Yet an examination of an old armoury will prove this to have been anything but the case. In the single combat, the chances undoubtedly are, within certain limits, with the longer sword. And yet use and experience seem to have proved that, for all general purposes, a rather under-sized sword was in the long-run most efficient. Is it not so with armies? For an army with the comparatively short-ranged smooth bore to meet another equipped with the long-range rifle, would in all probability be to court defeat,—a probability varying from certainty on a plain, to even chances on very broken ground. A commander cannot neglect any sudden improvements of his enemy. But when both armies come to improving their arms, and, as a necessary consequence, complicating highly their organization for supply and equipment, will they not, as with the sword, tacitly revert, after experience, to something simpler? The change being, perhaps, hastened, as all history demonstrates, when wars become highly complex, by some man with genius grasping the just medium to which complexity can be carried with efficiency, and, disregarding the long sword of his antagonist, closing with him victoriously. Wars, at all events, have not become more bloody since fire-arms and their improvements have come into vogue.

No. VII.

THE ZOOLOGY OF THE INTERNATIONAL EXHIBITION.

BY CUTHBERT COLLINGWOOD, M.B., F.L.S., &c.

SCATTERED up and down the vast building which has been the centre of attraction to so many thousands during the past summer, the lover of Natural History found ample material to attract his attention, and to encourage him, if he were fortunate to have at his command sufficient time to make a systematic examination of the contents, to devote a day to its zoological and botanical treasures. He would soon perceive, that although there were numberless nooks of the Exhibition which yielded something of interest in this department, nevertheless they were chiefly concentrated about the colonial courts, which in some instances were furnished with scarcely anything else but the animal and vegetable productions of the colony, accompanied by specimens of the raw material derivable from them. This fact at once affords an indication of the manner in which a brief sketch of this department of the Exhibition should be treated; and as the animals and vegetables were thus to a great extent geographically arranged, so also they should be described.

Let us first visit our most distant colonies, which, situated at the antipodes of this country, yield, as might be expected, some of the most remarkable forms of animal life. Victoria, which only emerged into an individual existence in 1851, and is now a flourishing colony of forty-seven municipalities, sent specimens of some of its curious marsupial animals. These creatures, represented by the Kangaroo and Wombat, are characterized by a pouch or bag, in which the young are carried for a considerable period after birth. This is rendered necessary by the fact that they are born in an imperfectly-formed condition, so that they are incapable of at once existing, like other mammalia, in the outer world into which they are rudely and, as it were, prematurely thrust. They are, therefore, immediately transferred into the maternal pouch, in which the teats are situated, and, fastening on to them, they remain snug and secure from danger. The new-born kangaroo is but an inch in length, blind, and with very rudimentary limbs and tail; and it is believed that this remarkable character has reference to the physical constitution of the country, where water is very scarce; so that, instead of leaving their young, as other animals would do, while they travel great distances to quench their thirst, they are thus enabled to carry with them their helpless offspring, in those long migrations which are necessitated by the scarcity of water. These singular animals are abundant in Australia and Tasmania, which thus form, as Forbes remarked, a peculiar zoological province, where we have the lowest conditions of the vertebrate type assembled, as if to indicate a rudimentary stage of the world's history.

One genus of pouched animals, the Opossum (*Didelphys*), is found in America, and another (*Cuscus*), is Malayan; but with these exceptions, they inhabit no part of the world but those just indicated.

In the Australian courts also might have been seen those remarkable animals the Duck-billed Platypus (*Ornithorhynchus*), and the Porcupine Ant-eater (*Echidna*), anomalous quadrupeds, closely allied, and constituting together the order of Monotremes. The former is aquatic, with a flattened beak, like a duck, and close-set fur, like a mole; the latter terrestrial and insectivorous, with a cylindrical tongue like the true ant-eater, and covered with spines like a hedgehog—both strictly limited to Australia and Tasmania. A very beautiful skeleton of the Echidna, prepared by Professor Hyrtl of Vienna, in the Austrian court, showed the curious marsupial bones, remarkably large in this species. These bones are two in number, diverging forward from the front of the pelvis, for the support of the marsupial pouch. It is not a little noticeable that they are also found in the males, which have no pouch. In some respects these two quadrupeds may be considered to connect the mammalia with the class of birds.

The productions of New South Wales, South Australia, Western Australia, Victoria, and Queensland, may for all purposes be considered together, having very much in common; and with them may be included Tasmania. In all are found the characteristic marsupial animals, of which the

Kangaroo is the best example; the Great Kangaroo, however, is becoming scarce, though the Red Kangaroo, now only found in the interior of New South Wales, is much rarer. The most common Tasmanian species is Bennett's Kangaroo, of which the meat is said by Mr. Gould to be excellent, and which it is believed might easily be acclimatized in our southern counties. The Tasmanian Devil (*Dasyurus*) could not fail to attract notice from its repulsive bear-like form, which is matched by its destructive habits; though the first settlers in Hobart-town repaid their devastations among the poultry by eating them. The flesh is said to taste like veal. The largest carnivorous marsupial, however, is the Tasmanian Wolf (*Thylacinus*), of which living specimens will be found in the Zoological Gardens,—a dog-like animal, striped on the back, fierce and agile, and the terror of the herbivorous Kangaroos and Opossums, though it is said it will not touch the Wombat (*Phascolomys*). A very beautiful case of male, female, and young of these animals, mounted by Ward, was in the Tasmanian court, and is now deposited in the Liverpool Museum. In the pleistocene deposits, however, has been found the skull of a great carnivorous marsupial, termed *Thylacoleo* by Owen, equalling the lion in size and strength; and in the New South Wales court was exhibited the skull, measuring three feet in length, of a vast marsupial, allied closely to the Kangaroo, and called by Owen, *Diprotodon*, another relic of the pleistocene deposits of this singular island.

Some interesting birds were observable in this department. Like the quadrupeds of these regions, the birds are also very strange and peculiar; as, for example, the Apteryx, which inhabits Australia and the islands of New Zealand, and of which three species are now known. These wingless birds, belonging to the Struthious division (which includes such birds as the Ostrich and Cassowary), are almost the only representatives of a class which not long since were tolerably plentiful. As many as twenty species, from the size of a turkey to twice that of the ostrich, have left incontestable evidence of their existence in quite recent times, though now only three, or perhaps four, remain. The wings are reduced to the merest rudiments; the feathers have no accessory plume, and their shafts are prolonged beyond the back. They differ, too, from other birds in having a complete diaphragm, and no abdominal air-cells. These birds are nocturnal in their habits, of weak powers of resistance, and therefore easily fall victims to predatory animals; while their skins are also eagerly sought for by the native chiefs, who ornament their dress with the feathers. They live on worms, insects, snails, &c. In the Exhibition of 1851, it will be remembered that another wingless bird, though of a different class,—the Dodo, but recently extinct, formed an attractive and prominent feature.

The most gigantic species, however, of these wingless birds was well represented by a beautiful model of a skeleton, in the Austrian court, among the illustrations of the late Government exploring expedition undertaken in the *Novara* frigate. This bird, the *Palapteryx ingens* of the palæontologist, was found in a cave in the Awatere valley, in the province of Nelson, south isle of New Zealand. The original skeleton is at Vienna. But that which gives these birds their greatest interest is the possibility, or even probability, that one species—it may not be the largest—is still existent, though rare, in the middle island of New Zealand, where it is called by the natives the *Moa*. Fragments of the eggs of some of these great birds have also been discovered in New Zealand, bearing a great resemblance to those of the Apteryx, having a thin shell and smooth surface. The Emeu (*Dromæus Novæ Hollandiæ*) is the Australian representative of the ostrich tribe, of large size. This fleet bird, which affords excellent sport to the hunter, is also gradually disappearing before civilization, though at present rather widely diffused over South Australia and the neighbouring islands. Its eggs, which might be seen in the Western Australian department, are dark green, and six or seven in number. Some tippets and muffs also were exhibited, formed of the feathers or skin of a newly distinguished species, first recognized by Mr. Bartlett.

In the South Australian court also was exhibited the *Talegalla* (with a representation of its nest), another of those characteristic birds with which these regions abound. Mr. Gould, who visited Australia with the ardent enthusiasm of a true ornithologist, has given us the best account of this bird, and places it among the *Rasores* (or domestic fowl tribe), and considers it as the Australian representative of the Turkey, which it equals in size.

The Talegallas are gregarious and shy, rapidly running through the tangled brushwood. They utter a loud clucking noise as they stalk about the wood; and, like the ruffed grouse of America, when perched on the branch of a tree, they will sit composedly to be shot at repeatedly till they are all brought down. The most wonderful part, however, of the history of this bird is its nest. It collects together a great heap of decaying vegetables as the place of deposit of its eggs; thus making a *hotbed*, arising from the decomposition of the collected matter, by the heat of which the young are hatched. Mr. Gould describes this heap as the result of several weeks' collection by the birds previously to their laying, and as varying in quantity from two or four cartloads, and of a perfectly pyramidal form. It appears to be the united work of many pairs of birds, and the same site is used by them for several successive years. The Talegalla uses its foot for this work, and when sufficient is accumulated, the eggs are deposited about a foot apart from each other, and buried about two feet deep, perfectly upright, with the large end upwards; and there they are left, as in an artificial incubator, till they are hatched, when, it appears, that the chicks force their way out without assistance. The natives collect as many as a bushel of eggs from a single mound, and they are much sought after on account of their delicious flavour and large size (3¾ in. × 2½ in.). These remarkable statements of Mr. Gould have all been verified by the behaviour of some of these birds kept in confinement at the Zoological Gardens, Regent's Park, where this strange method of incubation has been observed in every particular.

That *rara avis*, now so no longer, the Black Swan, was conspicuous in the West Australian court, it having been adopted as the emblem of that colony. It is characteristic of Australia, that it should have produced a bird which was once regarded as the symbol of impossibility, and put in the same category with the phœnix and the mermaid. But the pure white of the swan's down was so proverbial that our ancestors, who knew nothing of the extraordinary anomalies of undiscovered Australia, might well be excused from imagining a black swan, except as a joke, such as that which was alluded to under the terms *birds' milk* or *asses' wool*. Shaw first gave the Black Swan the name of *Anas Plutonia*, devoting the new wonder to the patronage of the infernal king. But really a black swan, except in colour, differs but little from our own wild swans, and the form of that characteristic part, the trachea, is intermediate between that of our wild Hooper and the tame swan.

The group of six Lyre-birds, in the Queensland court, doubtless attracted attention. They were first discovered in Captain Flinders' expedition in 1798, and since then have been bandied about among ornithologists, who were unable to agree as to their true position; they have now, however, finally settled into their place among gallinaceous birds. Their discoverer gave them a high character as song-birds, which, however, they have not succeeded in keeping. There is only one species of these splendid birds, whose superb lyre-shaped tails may well have astonished the Irishmen who formed the exploring party when they were originally found. Mr. Bennett says that these tail-feathers are sold in pairs in the shops in Sydney, though they are now becoming rare, and fetch from *twenty to thirty* shillings a pair. The Lyre-birds inhabit the forests of Eucalypti (gum-trees) and Casuarinas, and are, like many other Australian animals, becoming scarce.

The Bower-birds (*Ptilonorhynchus holosericeus*) also keep up the character of Australia for its anomalous productions. These birds, with a plumage resembling black satin, are allied to the Crow, and are most singularly interesting on account of the bowers from which they take their name, and which they construct as follows :—With great skill and dexterity they weave a sort of arbour of twigs, fixing them below in a bed of various materials, and decorating their promenade, which is of various length, with shells, feathers, and other ornamental materials, which they collect from the country round. This bower has no connection with their nest, which is built later, but serves apparently as a playground, in which they sport, and play at hide-and-seek, bo-peep, and a variety of similar amusements, which we should hardly expect to have found their way into bird-life. Their bower constantly occupies their attention. They arrange and rearrange the materials every day, placing about it everything within their reach which may by any means serve as an ornament to it. The habits of these birds have also been observed in the Zoological Gardens.

There are many other curious birds known to Australian settlers by peculiar names; such as the "Laughing Jackass," a large kingfisher, whose note resembles a rude powerful laugh, heard more especially at certain hours of the day; and hence it is sometimes called the *Settler's Clock*. Here, again, we have kingfishers which do not fish, indeed seldom come near the water, but feed upon mice, lizards, &c. Australian birds do not excel in their powers of song; and even we English do not usually impute much sweetness of voice to our crows and rooks; but there are few birds with a richer whistle than the Australian piping crow (*Barita tibicen*). Both these latter birds were exhibited in the Victoria court. Parrots and cockatoos, also, the flocks of which annoy the settler by their depredations in his plantation, and by their harsh discordant screams, are characteristic birds. Some of these cockatoos also are black, as the New South Wales court testified; though they do not breed in open mossy nests, as there pretended.

The Victorian exhibition included a number of fishes well preserved in spirits, showing the great resources of this colony. Among these the Murray River cod, or cod-perch (*Oligorus Macquariensis*) was conspicuous, and is said to attain a weight of ninety pounds. It is abundant, and the market is regularly supplied with great numbers of a large size. The Snapper of the colonist (*Pagrus unicolor*), is equally important, though of inferior flavour. The great Maigre (*Sciæna aquila*), is much larger than either of these, and, it is said, a finer fish for the table. It reaches a length of five feet. The mullet, whiting, and herring, so called by the colonists, are all common fishes, but not identical with our European fishes of those names. The short sun-fish of Europe is often taken in Hobson's Bay, and valued for the oil it produces. A species of tunny and an eel are also commonly used as food.

Until recently no true lobsters nor crabs were known in Australia fit for the table; but a spiny crayfish, equal in size to our river species, is supplied to the markets; and the gigantic Murray River crayfish (*Astacoides serratus*),* is also now largely used. An enormous crab, exhibited in the Victorian court (*Pseudocarcinus gigas*), was lately found near Portland, and preserved for this occasion.

But we must pass on to the examination of other courts. The Eastern hemisphere sent but little of a zoological character; the chief feature being found in the Indian and Cinghalese departments. The royal Bengal tigers, prepared by Mr. Ward, of Vere Street, were very striking objects, being represented in the midst of the jungle, the one slinking back, so as to realize the first glimpse obtained of the creature by the party hunting it, as the line of elephants approached its lair; the second tiger was also represented in the jungle, wounded, and charging with fury upon the attacking party. Both were very creditable specimens of the taxidermist's art.

The gorgeous state of Eastern potentates is assisted and enhanced at the expense of some of the most beautiful of the feathered tribes; and peacock's feathers, and marabout's feathers were shown in every condition, to the exclusion of any illustration of the vast and imperfectly-known ornithology of India. The tail of the Yak (*Poephagus grunniens*), which is rich and silky, reaching nearly to the ground, was shown, mounted in a splendid handle, and is used for various luxurious purposes. Indian silk was illustrated in an instructive manner; the silk-producing moths being exhibited in their various stages of metamorphosis, with their food, and specimens of the silk of each kind accompanying.

Ceylon showed her ivory, skins of tigers and cheetahs from the northern province; monkey and goat-skins from the other provinces. Here also might be seen the little musk-deer, measuring seventeen inches long and weighing only about five and a half pounds. Pearls and pearl-producing shells characterized the exhibition from the eastern province.

South Africa contributed hippopotamus' teeth, rhinoceros' horns, skins of those singular armour-plated animals, the Pangolins (*Manis*), closely allied to the Ant-eaters, and termed Edentate, from the absence of incisive teeth. They are scantily distributed and find no representatives in Europe. Antelopes here abound, but true deer there are none, the only African species known inhabiting the northern parts. But South Africa is the head-quarters of the antelopes, as Asia is of the deer; the former have persistent horns, but the latter shed them periodically.

Turn we now to the Western World. The courts appropriated to our colonies in America and the West India islands contained many objects of the greatest interest. The tropical regions of British Guiana were represented by several strange mammalian forms, birds of strange shapes, and some characteristic vegetable productions. Among the former may be reckoned the Great Ant-eater (*Myrmecophaga jubata*), one of the Edentate group before mentioned. In this animal we have an extraordinary prolongation of the muzzle, the bones of the face being double the length of the skull, and the organs of mastication being absent; but they possess a long cylindrical tongue covered with a glutinous saliva, by means of which they secure insects, and draw them into their little mouth. This tongue is of extraordinary length, nearly twice as long as the whole head and muzzle put together, and when not protruded it is kept doubled up in the mouth with the end pointing backward; with its powerful crooked claws it opens the great South American ant-hills, and although sluggish in its ordinary movements, it uses its tongue with such rapidity, that it is asserted that he will project it and withdraw it covered with insects twice in a second. The use of its immense bushy tail was apparent when we once had an opportunity of seeing this animal compose himself to rest. Lying down on one side, he planted his long snout amidst the thick fur of the belly, and then locking the fore and hind claws into each other, he reflected his tail, so as to cover his whole body as with a blanket. Thus in his native savannahs he probably shelters himself from the too powerful rays of the tropical sun.

Near this animal might be seen another, singularly differing from it in form, though closely allied to it in structure, also Edentate, the Sloth. Here we find the bones of the face short and round, giving the animal a physiognomy akin to that of the monkeys, and the organs of mastication deficient only in incisor teeth. But they possess none of the advantages which monkeys have in the mobility and flexibility of the fingers, nor any thumb; and though they are, like them, arboreal in habit, they hold by means of hooked claws, by which they usually hang with the back downwards. Few animals have been more maligned than the poor sloth, the account of whose habits, by Buffon, gives a vivid but incorrect statement of its pitiable lot. But, as Mr. Waterton observes, "he travels at a good round pace, and were you to see him, as I have done, passing from tree to tree, you would never think of calling him a sloth."

But Buffon, trusting too implicitly to rumour, gave the ant-eater the credit of climbing trees, which it never does.

A very splendid case of animals in the New South Wales court may be appropriately referred to in this place, inasmuch as their native country is South America, from whence they have been transported to Australia, with the hope of acclimatizing them, and making their habits and their economy alike useful in that distant continent. These are the Alpacas and Llamas, the species of Auchenia. This case contained seven animals of the brown, grey, and black varieties, and well illustrated the important advances which the colonial breeders were making in the production of *lustrous long wool*, by means of judicious selection in breeding; in which particular the exhibitors express themselves as sanguine that in a few years they will not only compete with, but surpass Peru, from whence the animals originally came. The pure alpaca has a finer, heavier, and longer staple of wool, than the pure llama, but a dash of llama blood infused into the alpaca produces a larger framed, hardier constitutioned, heavier, finer, and more glossily-fleeced animal than could ever be obtained by the close in-and-in breeding so zealously carried out by the Indians of Peru. One remarkable use of these animals in Australia, is the following:—Previous to the arrival of the alpacas the native dogs caused great havoc, both by day and night, to a flock of sheep; since their arrival, however, they have not been troubled by these pests; and every day may be seen a few sheep accompanying one of the flock to graze, returning with it at sunset to fold. In South America it is customary to have eight or ten wether alpacas with a flock of one thousand ewe sheep; these alpacas conduct the flock to pasture, defend it from the foxes, condors, and strange dogs during the day, and bring it back to fold by sunset. They attack the dogs in concert, and with boldness, using their fore feet as offensive weapons, and with good effect. The supporters of the alpacas in Sydney unhesitatingly declare that the perfect acclimatization of these animals in that colony is no longer a matter of doubt.

The Jaguar (*Felis onca*) of the British Guiana collections, together with the Ocelot (*F. pardalis*), and the Puma (*F. concolor*), represent the great cats in America, where the lion, tiger, and leopard are unknown. The jaguar is an expert climber of trees, and although not very dangerous to man, commits great havoc among small animals and the flocks and herds of the Indians. They are very numerous, and according to Humboldt, 4,000 are killed annually in the Spanish colonies, and 2,000 are yearly exported from Buenos Ayres alone.

The peculiarities of geographical distribution were well exhibited by the monkeys of this region, several of which were shown in the Guiana court. The monkeys of this continent differ in so many important points from those of the Old World that they may be considered as a distinct type. Here we have a different dental formula, all Old-World monkeys having thirty-two teeth, while those of America have thirty-six. The latter never possess callosities nor cheek-pouches; the thumb, which is so constant in the case of monkeys of the Old World, is often absent from the fore-feet of American monkeys, which are also of a generally smaller size, and possess a different physiognomy, arising from the very different form of the septum of the nose. But one of the most striking peculiarities is that the tail of American monkeys, instead of being sometimes absent, as in the apes and magots of Africa, is always present in some form, and usually is prehensile, forming an additional hand, which is used with wonderful facility and judgment, as may be seen by any one who will visit the Entellus monkeys now in the Zoological Gardens. Among the South American monkeys, the Red Howler was most noticeable in the Exhibition, an animal with a singularly stentorian voice, calculated to make night hideous in the gloomy and pathless forests of South America.

Nor are the birds of these regions less striking. The case of Humming-birds well illustrated a class of fairy denizens of the New World, such as are not vouchsafed to any countries of the Old—radiant-winged gems—the souls of the warriors who had died in defence of the gods—as the Mexicans fabled.

"Exquisite ornaments are these to an Indian garden," says one who has seen them in their native state, "where they delight in the flowering plants and shrubs. They creep to and fro about the stalks and twigs, clinging by their little purple feet, and rifling the tubular corollas of their honied blossoms, where, doubtless, they gather many minute insects, licked up with the nectar, by the aid of their curiously-pencilled tongue."

The Boat-bill (*Cancroma*), a bird of the heron tribe, attracts attention by his singular beak, like a boat turned upside down. It is a handsome bird, with a long crest hanging backward over the neck, inhabiting Guiana and Brazil. Perched on a tree over a stream, it drops down like a kingfisher upon the passing fish, and seldom misses its finny prey. Its name would indicate that it feeds on crabs, but this seems at least doubtful. Bitterns, horned screamers, Pompadour chatterers, and a variety of other birds, show the ornithological riches of these regions; but few birds are more beautiful than the toucans, whose brilliant plumage and painted beaks make a splendid appearance. The light spongy substance of their delicately-tinted mandibles prevents them from being impediments to motion, as it might be supposed they were; and the same may be observed of the closely allied birds called Hornbills (*Buceros*), with which, however, they must not be confounded, for the latter are confined to the Old World, while the former are only found in the New.

The Canadian exhibition contained many northern birds, as the snowy owl, great-horned owl, whip-poor-will (a species of goat-sucker);—the American purple martin, passenger pigeon, and yellow-billed cuckoo—birds which have been met with in this country; the northern humming-bird (*Trochilus colibris*), the cedar-bird, the Canadian goose, canvas-backed duck, American wigeon, shoveller duck, &c. Fishes, also, to the number of nearly forty, representing the resources of the lakes and rivers of Upper Canada, were shown; among which the salmon, herring, &c., representing an export value of several hundreds of thousands sterling per annum, were conspicuous. The salmon ascends the river St. Lawrence for 1,200 miles in order to spawn, and vast numbers are annually taken.

Nova Scotia, also, sent her fish, but well preserved in spirits, such as the mackerel, herring, cod, salmon, hake, flounder, eel, haddock, trout, whiting, &c., and several edible mollusca, such as the solen (razor shell), Virginian oyster, and the great mussel (*Mactra gigantea*); also the enormous American lobster (*Homarus Americanus*), with claws measuring fifteen inches in length and weighing several pounds. In the centre of the court stood a splendid specimen of the largest of existing deer, the elk or moose (*Cervus alces*), said to be the largest stuffed animal in the Exhibition. The horns sometimes exceed 60 lb. in weight, and, as an old writer says of him, "The elk is a monster of the venison sorte; his horns exceed (in weight) all creatures which the New World affords." He does not attain his full growth until fourteen years old, and then reaches a weight of eleven or twelve hundred pounds. A fine pair of horns, also, of the Wapiti deer (*Cervus Canadensis*), decorated this court—an animal resembling in appearance the red deer of Europe. Its flesh is not so highly prized as that of the elk, and that perhaps will prevent its ever being largely domesticated in this country, where it readily thrives. The other contents of this court were chiefly skins from the *barren grounds*, the great source of those furs that are at once the comfort and the bane of the poor animals which yield them with their lives to the civilized luxury of man. In these treeless tracts roam the glutton, the ermine, the bear, the Arctic hare, and the reindeer, which last stands as "a representative of the verge of realms of ice and snow" beyond. Some of these animals are so pursued, on account of the value attached to their skins, as to be almost extinguished; and the local government of Nova Scotia was unable to obtain a skin of the black fox, owing to the large price paid by the Russian nobles for this favourite fur.

Although, however, the Colonial courts contained the mass of the natural history of the Exhibition, there were many interesting specimens found incidentally in other parts, at which we will, in conclusion, briefly glance. In the Austrian court, Professor Hyrtl's preparations of anatomy and osteology were deserving of the highest praise, and a medal is most properly awarded to him for them. They contained, among other things, a series of the ear-bones of man, and of many mammalia and birds—a monument of the anatomical skill and learning of the preparer, which was valued at £200. Several important skeletons also were by the same professor; among them that of the Chlamyphorus, a most singular creature, of which only one other exists in Europe,—viz., in the British Museum; and as these were both found at Mendoza, in Chili, which has since disappeared, with all the surrounding territory, from the surface of the earth, by an earthquake, which, in 1861, engulfed it with 14,000 souls, it is probable that all the Chlamyphori have been destroyed. This skeleton has been purchased by the Royal College of Surgeons for £40.

Some very fine articulated skulls were shown in the French court, by Guérin, Rue Rouen, Paris; and near them were the remarkable preparations and models of Dr. Auzoux, which also obtained a medal. The doctor terms them preparations of Clastic Anatomy—from κλάω, to break—because his models are composed of solid pieces, which can easily be mounted and dismounted, and are removable one by one, as in a true dissection. He showed a complete model of a man, which could be detached in ninety-two pieces, showing two thousand parts in detail, the price of which was 3,000 francs (£120); also that of a horse, containing ninety-seven pieces, showing three thousand parts. There also were enlarged models of minute parts, such as the ears of mammals, birds and fishes, the larynx, tongue, &c.; and models, upon the same plan, of typical animals, belonging to all the great branches of the animal kingdom, and extremely valuable for educational purposes, though perhaps somewhat expensive, as we should not like to have to give £8 for a leech, or £10 for a snail or a cockchafer.

Some very beautiful wax models in the Italian department, by Drs. C. and S. Calenzoli, also obtain, as they deserve, a medal. They represented the history of the silkworm in all its stages, and were very extensive and interesting. M. Guérin-Meneville likewise obtains a medal for his labours in the introduction into France of the silkworms of China, India, and Japan, more especially the Ailante silkworm (*Bombyx cynthia*), a hardy species, feeding upon *Ailanthus glandulosa*, a hardy tree requiring little cultivation. It appears that more than a million of these trees were planted in France in 1861, and more than one hundred millions of seed sown, sufficient to cover 50,000 acres. This tree and silkworm are said to have already been successfully introduced into various parts of Europe, Africa, America, and Australia.

Lastly, the Educational department contained many interesting collections and illustrations, by Messrs. Bartlett, Ashmead, Wilson, Damon, Wright, Robertson, &c., who in their different departments of Zoology and Physiology all obtained medals.

We are now compelled to bring this survey to a conclusion. It cannot be said that zoology and the taxidermist's art were badly represented, though doubtless, as in all other things, bad and good were mingled together. The preparation of animals, and their preservation for the museum, is a highly important art, perhaps not sufficiently recognized: it demands at once manual skill, experience, taste and knowledge of natural history, the first being useless if it be not guided by the last. Nothing is more pitiable than to see nature violated by the hands of an ignorant stuffer, as was sometimes the case in the late Exhibition, and false ideas derived from such abortions are more easily received than eradicated. The preparation of animals is certainly an art which is undergoing improvement—more taste is shown in the accessories, more grace and nature are imparted to the form, and more life to the object from which real life has departed; and had all the zoological collections been arranged together, as was the original plan of the Commissioners, a comparison of the different performances of the taxidermist would probably have led to useful results by stimulating the skill and energies of the inferior workmen; but the exigencies of the Exhibition imperatively demanded that everything should be geographically arranged, and it was found impossible to make an exception even in the Natural History department, where it seemed most desirable.

No. VIII.

THE COLONIES.

BY THE EDITOR.

PROBABLY it may be deemed a piece of superfluous information by many of our readers, when we state that the British Colonies occupied, with a display of their natural resources and local manufactures, the north-east transept of the Exhibition building; but it will most assuredly be gratifying to every one, whether or not he may have directed his attention to this department in the World's Fair, to know that it contained unmistakable evidences of thriving industry, active enterprise, and unlimited natural resources.

Let us return in imagination to these attractive courts, as they graced the world's bazar, and cast a hasty glance over their contained treasures.

Whether we inspect the tropical products of India, those of the more temperate regions of Australia, or of the vast Canadian forests, in whatever direction we cast our eyes, we meet with the same profusion of natural wealth that seems almost inexhaustible. But if we consider the application of these gifts of a bountiful Providence, as here represented, we are even more astonished than by the natural products themselves.

Woods—which we had supposed to be applied only to the coarsest uses, the lowly pine for example, associated in our minds with pitch and rosin—we here find polished and carved with such craft that no royal personage need feel ashamed to range the furniture constructed of its planks side by side with his cabinet of satin-wood or maple; and the almost worthless fruit, the "cones," in fact, of an allied tree, which in our own plantations cumber the ground, may here be met with, transformed by the hands of our fair sisters of New Brunswick into beautiful baskets and "what-nots."

Stray we into the court of "South Australia," we find the natural productions of the animal and mineral kingdoms curiously wrought into costly ornaments, which speak of a rapid progress in art and civilization; whilst, at "Natal," the very sea-weeds are utilized and converted into the useful appliances of every-day life.

But we are anticipating, and will now invite our readers to accompany us in a stroll through this department of the Exhibition, during which we will endeavour to point out those objects that recommend themselves to our notice from their rarity, utility, or novel application.

As we enter the north-east transept, and approach the courts of the Antipodes, our attention is arrested by a series of water and oil colour drawings, which not only possess considerable merit as works of art, but representing, as they do, scenes illustrative of life in these remote colonies, and of the dangers to which the settler is subject, may well serve as a frontispiece to our matter-of-fact description of the treasures which are stored in the courts beyond.

Here we find transferred to canvas the sad story of a colonist who during his wanderings in the backwoods has missed his way; "Lost in the Bush; or, a Fern-tree Gully" is its title, which conveys but a faint idea of the incident depicted. In the centre of the picture lies the poor traveller, asleep or dying from exhaustion. His garments are of the most meagre and ragged description, and bear witness of many a weary and painful day's wandering through the "bush." His body is guarded by his faithful dog, an Australian dingo, who keeps at bay the vultures soaring overhead and awaiting the departure of the spirit, that they may pounce upon their lifeless prey. Close to the settler lies his horse, if the miserable collection of skin-covered bones may be so designated; and he, too, is surrounded by a hungry and expectant assemblage, a pack of wolves, likewise held at bay by the faithful dog.

But what a contrast with this picture of misery and death is afforded by the surrounding scene! High tree-ferns and other denizens of the forest, towering aloft in rank luxuriance, are visible on every side; but even these fail to hide the clear blue sky which peers calmly through their branches, as though it were looking down upon some joyous festival or merry-making; and all around we find a calm repose—a natural profusion!

But let us move onward a pace or two, and here we are amongst the "diggers." These are the "Bendigo gold-fields, with the town of Sandhurst in the distance," the Land of Promise, to which so many of our brothers and sisters, lovers and husbands (not always those, by the way, whose absence was to be regretted) have been attracted by dreams of gold. Here we have the gold-seekers' operations brought home for our "private view,"—and what a motley scene it is!

Diggers hard at work with picks and spades—Europeans, Yankees, Chinese, men of all climes and countries. Yonder is the digger's hut, and his lady at the door, attired in the gayest of colours, and bargaining with, we believe, a travelling pedlar. The different operations of the diggers are well delineated, and the distant town gives excellent effect to the picture.

There are views of other gold-fields; but we cannot stay to examine them, and must finish our frontispiece with another vivid sketch of colonial life.

It is a representation of the "Maories driving off Settlers' Cattle: an Episode in the late War."* Let us endeavour to recall the chief features of the scene.

In the foreground, we have a group of natives concealed in the "bush;" the men are armed with rifles, which they are discharging in the direction of the settler's house; whilst a woman, with uplifted axe and with eyes flashing fire, spurs them on to the conflict. Beyond, to the right, we have the broad cultivated fields of the colonist, through which the Maories are driving away his oxen and other cattle, as well as his horses, ready saddled and bridled for use. Here and there, one of the natives, bringing up the rear of the marauders, turns round to fire at the pursuers. These are not visible on the scene, but the quarter from which they are advancing is indicated by their heavy fire and the rolling clouds of smoke.

It is, indeed, a bold and stirring picture! Yonder, on a slight eminence, is a barn or outhouse which has been set on fire by the plundering Maories; whilst in the foreground, concealing the colonist's party, is a magnificent tree-fern, such as we met with in the picture of the "Fern-tree Gully," and which affords great relief to the various stirring incidents represented in the other portions of the picture.

This is our frontispiece—as presented to us by the colonist himself in illustration of the scenes which characterize his checkered life. Now let us enter his show-rooms and examine the fruits of his industry and enterprise.

The first court to which our attention is directed is that of *Tasmania*, which is completely surrounded by a high wall of polished planks—woods indigenous to the colony. Here we will enter, and examine, first of all, this beautiful cabinet, the material of which offers a rather difficult problem for solution. "Is it of satin-wood or bird's-eye maple?" we ask of the gentleman in charge of the court. It has the mottled appearance of the latter, with the wavy lines of the former. Taking us to the great "trophy" of woods in the centre of the court, the conservator of these treasures shows us, with a smile, a polished plank of the same wood as that of which the cabinet is constructed. "It is the Huon Pine (*Dacrydium Franklinii*), one of the most valuable trees in the colony."

* By W. Strutt.

We need hardly describe our surprise at finding so ignoble a tree converted into so elegant a material; nor is it necessary that we should draw the attention of our English cabinet-makers to this beautiful wood, for our guide told us that several have already bid a high price for the plank which we were examining, and certainly a more beautiful specimen has never come under our notice. The Huon pine, we are told, is used for veneer, and costs in the colony about sixteen shillings per hundred superficial feet.

Returning to cast another glance at the beautiful furniture into which this wood is manufactured, our attention is arrested by various other kinds, of which the planks are of gigantic proportions; and, on expressing our surprise at this, we receive from our conductor the following information:—

"The three most remarkable specimens of Tasmanian wood are too large for exhibition even in this building, but they may be seen in the Horticultural Society's gardens. There may be found planks of white gum (*Eucalyptus viminalis*), blue gum (*E. globulus*), and stringy-bark (*E. giganteus*), varying in length from eighty, ninety, or one hundred feet, to one enormous spar three hundred and fifty feet in height!"

What an idea this imparts of the towering trees which constitute the forests of Tasmania!

The use, we are told, of these descriptions of wood is chiefly shipbuilding, and more especially are they adapted for the "knees" of vessels, * for which purpose their great strength renders them very valuable. Indeed, one piece of "blue gum," in excellent preservation, is exhibited which has been forty-five years in use.

"But what," we ask, "is the use of that great canoe?"

"That is a portion of the paraphernalia of the sperm-whale fishery; and here we have the other appurtenances of this industry: the instruments of destruction, paintings of the ships employed in the trade, the casks in which the oil is stored, the 'head-matter' in a bottle, the teeth and jaws of the sperm whale."

Let us here remark, *en passant*, that throughout the Colonial Courts we could not help admiring the pains taken by the exhibitors to display in a perfect manner the whole of any industry; and we shall often have occasion to notice the completeness with which each has been arranged, to the advantage of those who desired to find in the Exhibition something beyond a mere show, and to the great credit of the exhibitors.

But we must leave the sperm-whale fishery and the huge logs and planks of timber, and pass on to a subject of deep interest in this colony.

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* Hickory-wood is the kind employed for "knees."

"These enormous, blooming apples and pears," we ask, "are they indigenous?"

"They are wax models of fruits which have been introduced from the mother-country, so you may judge of the prolific nature of our vegetation. Our cereals, too, are magnificent." (By the way, to judge from the praises bestowed upon their cereals by the representatives of *all* our colonies, we need never stand in fear of a famine at home.) And, certainly, the specimens exhibited to us fully bear out this designation, for the ears of wheat and Indian corn seem bursting with their contents.

But our time and space will soon be exhausted if we tarry here any longer, so let us glance hastily at these excellent photographs of unprepossessing aborigines; then we will cast a wistful eye over the beautiful jewellery exhibited by our courteous guide, Dr. Milligan,—jewellery which testifies to the wealth of the colony in precious stones; for here we have the topaz, jacinth, cairngorm (magnificent specimens!) crystals, carnelian, garnet, and opal; and let us finally conclude our visit with an expression of admiration at the ingenuity of our Tasmanian brethren in barking their trees and, instead of throwing away the bark, preparing it for the market, and offering it at £4. 10*s*. per ton for the manufacture of paper!

Adieu, now, to Tasmania, and greeting to Victoria,* as we pass through it to the courts of the Australian continent.

Passing on to the *New South Wales* Court, we find several interesting productions of the colony, some indigenous and others introduced and cultivated there. There is, for example, the beautiful maize-plant (*Zea Mays*), standing eight feet in height, and the corn from which is the most conspicuous amongst the different kinds of grain. The other chief products of the soil, of which specimens are exhibited, are wheat, tobacco, cotton, and a collection of woods not second to those in "Tasmania." Here, too, we have handsome pieces of furniture, and one beautiful cabinet, constructed of polished cedar, is remarkably conspicuous.

But the most interesting feature in this court is to be found amongst the animal productions, more especially in the application of that useful animal the kangaroo; and we venture to say that few Englishmen are aware of its full value to the colonist.

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* It was in an unfinished state when we visited it, and the description of its contents must be left to abler pens than ours.

Amongst the articles made from its skin only we have here whips, saddles, bridles, and other equipments; boots and shoes innumerable (which command the admiration of all visitors, on account of their excellent workmanship), mill belting, &c. &c.

Silk, too, has been recently introduced into the colony, and the specimens exhibited speak very favourably for its permanent culture.

But what do our manufacturing friends say to the wools; the beautiful specimens of which, both washed and unwashed, merino and alpaca, cannot fail to call forth their admiration?

Lastly, but by no means the least interesting, are the mineral productions, of which we can only notice the gold.

Nothing can be more interesting than the manner in which the precious metal is here displayed in every form and stage of its production and manufacture. First, we have about fifty samples of the various forms in which the gold is found in different parts of the country.* And side by side with these there is an equally interesting collection of earths, illustrative of the different deposits which are met with in sinking for gold in various parts of the colony.

The depth below the surface at which the auriferous deposit is found appears to vary considerably, being in some places (Peel River) close to the surface; whilst in others (Rocky River) it is necessary to penetrate about eighty feet into the earth, through soil, clay, basalt (nodular), and soft sandstone; and the "auriferous drift" is here found to be six feet thick, lying upon a bed of soft granite.

But the colonists do more than raise and wash their gold, as we cannot fail to perceive on leaving the court; for here we have two works of art, valuable not only on account of the material in which they are wrought, but also because of their exquisite workmanship.

They consist of a kangaroo and an emu, about six or eight inches in height (so far as our memory serves), formed of solid Australian gold, and each is mounted upon a kind of pedestal or rock of malachite. The workmanship is, as already remarked, of the first order, and the same observation applies also to other beautiful specimens of jewellery; but our limited space again compels us to leave these treasures, and travelling onward we arrive at the colony of *Queensland*, that portion of our Australian settlements to which at the present time the hopes of our cotton manufacturers are so anxiously directed.

That this is a young colony is manifest from the products and manufactures which it exhibits. No such beautiful cabinet-

s above thirteen ounces.

ware or jewellery as adorns the older settlements is here to be met with; but the conspicuous articles are raw cotton and wools. Of the former there are several beautiful specimens, some grown from the Sea Island seed, which is equal in value to that imported into Liverpool from New Orleans; and the wool is remarkable for its long silky fibre, and is chiefly from the Mauchamp breed of sheep. The staple of one very prominent specimen of wool is nearly six inches in length.

The woods of Queensland are also interesting, and their uses various; those which are exhibited being chiefly employed in cabinet-making; but, as just remarked, the young colony, although it gives great signs of promise, cannot yet compete with its older neighbours; and we shall now leave it for the purpose of inspecting the contributions of

South Australia. The most beautiful specimens of wheat of any that we have met with in our little tour through the colonies were shown to us in this court. One sample weighed above sixty-eight pounds to the bushel, and the flour produced from it was of unexceptionable quality. Almost as fine was the barley, and more interesting than either, the implement employed for their harvesting. The "reaper" which is exhibited in this court is certainly an unwieldy machine compared with those employed in England (not that *they* are very elegant); but then it reaps, gathers, thrashes, and winnows,—a series of operations in the performance of which our less aspiring agriculturists are satisfied to employ three different machines. This complicated implement is rendered necessary by the scarcity of labourers in the colony; and how it fulfils its various duties we are, for obvious reasons, unable to inform our readers.

If the vegetable productions of South Australia be interesting, equally so are its minerals; amongst which may be mentioned the malachite, of which crude specimens, as well as those wrought into objects of *vertu*, are remarkably conspicuous.

Although not strictly coming within the scope of our observations, we may refer, lastly, to the interesting ornaments formed of emu eggs, beautifully mounted in silver. Two emus in chased silver support the fine ebony-like egg upon their backs, and on the top of the egg stand two natives, also wrought in silver.

These and other similar ornaments speak well for the taste and ingenuity of the colonial artificers; and we could find themes amongst these beautiful articles of *vertu* for many laudatory observations. We must, however, travel on until we get to

Western Australia, concerning which we shall have a word or two to say before quitting this great section of our empire.

The Commissioners of Western Australia have so ably descanted upon the merits of their contributions,* that we cannot do better than allow them to describe, in their own language, those objects which chiefly attracted our attention.

Of the "Jarrah" tree (a species of myrtle) they say:—

> None of the other Australian colonies possesses timber of similar character to the Jarrah, or endowed with equally valuable properties.
>
> The Jarrah is remarkable for its enduring qualities, for its resistance to decay—setting at defiance time, weather, water, the white ant, and the sea-worm. One of the pieces of wood exhibited is a pile from a jetty in the sea at Freemantle, where it remained during a period of twenty-nine years. The lower portion was under water, exposed to the attacks of the sea-worm, which in those seas destroys every other wood in a very short time; the middle was between wind and water, submerged or exposed with every change of tide; the upper portion was always exposed to the action of the weather, to the intense sun of summer, and the long-continued rains of winter.
>
> Another piece of the same species of wood has been buried underground for thirty-one years untouched by the white ant, and which in a few months destroys every other kind of wood so circumstanced.
>
> For this valuable quality, the Jarrah is now much sought after for railway sleepers in the other Australian colonies and in India.
>
> The Jarrah, when better known, will doubtless be found available in the ports and dockyards of the United Kingdom for piles, dock gates, and other purposes for which Hyamised woods have been found inefficient. It is also admirably adapted for keel-pieces, kelsons, and other heavy parts of ship-building.

The pretensions of the wheat, too, fall very little short of that exhibited in "South Australia," one specimen being marked 66 lb. to the bushed; and the reader will not be surprised that such beautiful cereals should be produced in a country the climate of which is thus described in an official report of the Colonial Secretary, 1858:—

> I believe that, in general salubrity of climate, Western Australia possesses a marked superiority over any of the Australian colonies. It is subject to no extremes of heat or cold. Cattle have never been known to die from lack of water, and in the very driest weather there is a sufficient supply of food for them. Exposure to weather, by night or day, appears to produce no ill effects on the constitution of the colonists, many of whom, for months together, rarely sleep under any beyond the most temporary dwellings. Snow is never seen; ice only in the depth of winter, and then only in the very early morning. As in New Zealand, both maize and potatoes ripen in this country, and the latter crop is grown to a considerable extent. The apple and the pear, the orange, banana, fig, peach, and apricot, with the melon and

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* Descriptive Catalogue (no publisher named): A. Andrews, Esq., London Commissioner, 2, Church Court, Clement's Lane.

the vine, grow luxuriantly, and may be seen ripening at the same time. The colony is peculiarly adapted to the growth of the vine, on the cultivation of which much attention is bestowed, and which is likely to prove very remunerative. English and tropical vegetables are largely cultivated, and yield profusely. Attention is also being directed to dried fruits; and specimens of figs and raisins that have been sent to the periodical horticultural exhibition for competition are little inferior to those imported from Europe.

Let us now depart from this land of promise,—from this vast field for the enterprising and adventurous; this storehouse of wheat, timber, wools, and gold! And indeed we leave it with regret, for it has filled us with pleasure to witness the boundless resources and growing enterprise of our Australian colonies. But we have still to survey much that is equally interesting; and crossing, therefore, the Indian Ocean (or, we ought rather to say, the north-east transept), we find ourselves safely landed in the island of *Ceylon*, amongst new scenes, new products, and novel ornaments and appliances.

Here we are unmistakably in the Land of Cinnamon; and the most interesting, because the most complete, feature in the Ceylon Court consists of the objects and pictures illustrative of the culture of this plant. This is one of the examples, to which reference has been made, of the care evinced by the exhibitors to render the visitor perfectly acquainted with the whole of any particular branch of industry; for in this case we are, to all intents and purposes, transported to Ceylon itself, to witness the different operations upon a cinnamon plantation.

First, our attention is directed to a series of excellent photographs. One represents a native cutting the cinnamon (and then our guide shows us the tools employed for the purpose); another is that of a native labourer peeling and scraping; a third, sorting and baling; and here we have the cinnamon itself, tied up in bundles very much resembling the sticks round the axe of a Roman lictor. And what sticks! if our memory serves us aright, they are between four and five feet in length.

Lastly, to complete this branch of industry, we have samples of various oils, extracted from the roots and leaves, which are used for medicinal purposes.

Turning to another part of the court, we are struck with the appearance of a number of variegated but handsome walking-sticks, which, our guide tells us, represent the various woods of Ceylon; and amongst them may be found the coffee, cocoa-nut, satin, cinnamon, and a variety of other woods. Whilst admiring these specimens of Ceylon woods, our eye is attracted by the title of the exhibitor, whose name, "A. Mendis, Modliar," is conspicuously printed upon a card; and we are induced to inquire, "What is a Modliar?" "He is a native officer of the British Government;" and we are shown a photograph of one in his official robes. These "Modliars" are the chief exhibitors. They have sent specimens of oils, camphor, rice, carved-wood ornaments (one gentleman, who stands possessed of the name of Mr. Weiralasirinayana Absyaratine, exhibiting a beautiful piece of furniture of carved ebony), whilst the "Ceylon Committee" contributes the spices for which the island is so famous.

A curious and most valuable substance exhibited in this court, and which is also found in "Queensland," is the oil of the dugong, or halicore, an animal allied to the seal. The oil is white and solid, and is employed for the same purposes as cod-liver oil, viz., as a tonic in cases of consumption, possessing the additional advantage of being entirely free from any nauseous properties, and devoid of taste or smell. It was introduced into England by Dr. John McGrigor Croft; but beyond this we could gain no satisfactory information concerning its history.

But we must now travel northward, crossing over to the continent of India; and in the World's Fair we are compelled to retrace our steps, and, once more traversing the transept, we must mount to one of its galleries. Here we shall find a most courteous and able expositor of the treasures of Inde in Dr. Forbes Watson; and our readers shall have the benefit of the interesting information which he gave us concerning those products of the soil which now, more than at any previous period, possess such a deep interest for our countrymen.

First of all, we are shown a kind of skeleton stand, composed of a series of circular shelves, situated one above another, and in this are ranged 300 bottles, each containing the sample of a different growth of cotton; and Dr. Watson further hands us an illustrative plate, showing the lengths of the staple of cotton produced respectively from "native" seed, from "New Orleans, or American," and from "Sea-Island and Egyptian" seeds.

Next in importance to the cotton culture is that of tea; and here, again, we are shown a variety of specimens, the number being almost incredible.

Dr. A. Campbell, who collected these teas from the various provinces of India, showed us 142 different samples contributed by fifty estates. Of these the most valuable are the "Darjeeling" teas, from the Himalayas, of which 10,000 lb. only have been produced this year; but the exhibitor stated that next year the quantity would, in all probability, be increased fivefold. Dr. Campbell values the finest Darjeeling tea at 2*s*. 8*d*. per lb., exclusive of the import duty.

It is not generally known that the East Indian teas are of very strong flavour, and are chiefly used for mixing with the lower qualities of tea sold to our labouring classes. We, however, tried several samples which the exhibitor gave us without any other admixture, and they have been highly approved by all who have tasted them.

Amongst the other luxuries (if tea can be so designated) exhibited here, we were much interested in, but not greatly edified by, that of opium in its various states of preparation: "crude ball" opium, "grain," and other forms in which this noxious substance is vended; and, as appropriate companions to this enervating narcotic, we found various intoxicating drinks used by the natives.

These consist of rice and date arrack, rum, and "country spirits," the latter being distilled from the cocoa-nut palm.

But if these alcoholic beverages fail to call up pleasant associations in our minds, we have here two other products of the vegetable kingdom, one of which especially is becoming every day of greater importance to our welfare at home. The first is indigo, of which, along with many other colouring materials, there is a goodly show; and the second, to which special reference must be made, comprises the various seeds used in the manufacture of oils and cattle-cake. The Bombay linseed, of which above 35,000 tons weight were imported into England alone in the year 1861, is the finest in the world, and commands the highest price of any in the market.

To give our readers some idea of the cause of its high relative value, we may just state the following facts concerning it:—Linseed yields two substances in crushing; viz., oil, used for painters' purposes, &c. &c., and the residue being cattle-cake.*

Whilst we write this, the value of linseed oil is £42 per ton, whilst that of linseed-cake is only £11 per ton. It is therefore obvious that the more *oil* obtained from the seed, the more valuable it must be.

Now a quarter of Riga linseed weighs 400 lb., and yields about 94 lb. of oil in crushing, the residue being inferior cake; whilst a quarter of Bombay linseed weighs 416 lb., yielding 132 lb. of oil, and the remainder fine nutritious cake, of considerably more value than that made from other seeds. This explains the increased worth of the Bombay seed. The linseed from Calcutta and Madras is but slightly inferior to that of Bombay.

Again, the finest refined burning rape-oil is extracted from the "Guzerat" rape-seed, grown in the province of that name, and exported from Bombay; so much so, that a considerable quantity of the so-called colza oil, imported from France and Belgium, is made from the seed originally brought from India to London and Liverpool, and thence re-exported to those two countries. How important must our colonies be to our welfare, when we find that the continental nations which supply us with food for our lamps come to England to purchase, for this purpose, the raw material which is brought from our own distant settlements. Besides the two already named, there are many other seeds yielding oil. Of these the chief are, teel, or gingelly, a small white and black seed; niger, a bright black seed; poppy, ground-nuts, &c. &c. As to the products made from these seeds, if cattle could speak, they would probably tell us that they frequently observe indications of the presence of the inferior cakes made from some of them in their linseed cake; but, as they *cannot*, that will remain a profound secret. We, however, have suspected the presence of the *oils*, which are for the most part colourless, and are largely used in France and the Mediterranean, in the *olive oil*; and wicked persons are in the habit of asserting, in the most barefaced manner, that they are largely employed for the purposes of adulteration.

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* No doubt all our readers who visited the Exhibition will have seen the seed-crushing process carried on in the Machinery department of the building, by Messrs. Blundell, Spence, & Co., of Hull.

The mineral products of India are not conspicuous, and the coal, of which there are the representatives of the five different fields now worked, is of inferior quality, and suited only for river steamers.

The specimens of silk, wool, and other animal products, are of the first order; and these lead us into what is, unfortunately for us, forbidden ground.

It does not come within our sphere to speak of the exquisite works of *art* which give such *éclat* to the Indian Court,—of the ornaments in silver and gold; of woven fabrics of such delicacy as to be almost transparent, and which are trimmed with gold and silver lace equally delicate. Nay, the further we venture into this court the more seductive does the exhibition become. These gorgeous ornaments of gold and silver; these caps and crowns, fans and punkahs; this beautiful carved furniture; these richly jewelled and inlaid arms; and such Cashmere shawls, gold-embroidered purses, caps, and slippers! . . . . but we must proceed no further, and, with a well-merited compliment to Dr. Forbes Watson, for what we consider the most perfectly arranged of all the colonial courts—and that is saying much—we must now bid adieu to the wealth of India, and hasten onward to

Natal. Although we cannot tarry long in this court, we have time to inspect the interesting model of a Kafir kraal, or encampment fortified against wild beasts, and equally wild inimical tribes. Or we may imagine ourselves for the moment to be emigrants, examine with interest the bush waggon and its appendages.

We may admire, too, the native cap, manufactured of feathers, and exhibited so prominently; and stay for an instant to hear that our colonists have commenced the culture of tea and silk, and that the sugars produced in the settlement are of excellent quality. In passing out, we cannot fail to notice the fine specimens of rhinoceros horns, nor to be struck with the display of native weapons, all of which speak of a population consisting largely of aborigines; and, leaving the colonists to develop their resources and push on the work of civilization, we now hurry onwards to the

Cape of Good Hope. The exhibition in this court is unique, and is calculated to cause surprise to one who has visited the remaining courts in which our colonies are represented; for it consists of a limited display of articles contributed by one individual, Mr. Ghislen.

This gentleman has done what he can to redeem the character of this important colony, which is absolutely unrepresented, wherefore we know not,* The most remarkable, and certainly a novel, feature in Mr. Ghislen's beautiful little museum is the application of seaweeds (algæ), instead of wood or horn, in the manufacture of whips, handles to cutlery, &c. The stems of a marine plant (*Ecklonia buccinalis ?*) are submitted to some hardening process, and then bronzed, painted, or gilt; and certainly they look very attractive when thus treated, and converted into riding-whips, &c.

In close contiguity to the "Cape" court, if it can be so called, is that of the "*Bahamas*," which deservedly commands considerable attention, from the beautiful shell ornaments contained in it. All our home-made articles of the kind are eclipsed by these exquisite objects, which consist of baskets, head-wreaths, &c., all of a beautifully translucent white. The buds of the flowers are composed of "rice-shells," the leaves of "cup-shells," and the effect produced by this combination surpasses our powers of description. Why do not our English jewellers direct their attention more earnestly to the employment of such beautiful productions of nature as these? They would adorn a royal head, and far exceed in elegance much of the gaudy and fashionable head-gear now in vogue.

Let us once more cross over to the eastern side of the transept which we are exploring, and we shall there find, in close proximity, our colonies of *Trinidad*, *British Guiana*, and *Jamaica*, which present features worthy of consideration. Anti-abolitionists point to Jamaica as one of the ruinous results of the manumission of slaves; but, for a "bankrupt" colony, we confess that it contrasts very favourably with some of our solvent ones! The most interesting staple is decidedly sugar; and here, again, we find, what we cannot commend too highly nor too frequently—the complete illustration of this branch of human industry in all its various phases:—the sugar-cane; crude sugar, as extracted from the plant; molasses; very many samples of sugar as exported; about ninety samples of rum, and a great variety of liqueurs.

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* As we visited the Exhibition shortly after it was opened, other objects of interest may have been sent over subsequently.

Another very prominent product of the island is the lace-bark (*Lagetta lintearea*), and other similar substances, commercially know as "bast," and employed for tying up cigars and other manufactured goods. But it would be impossible even to enumerate the products of this rich island, for the mention of them would occupy as much space as this article. It asserts its claim to be considered a cotton-growing colony, not only experimentally but practically. Its animal, vegetable, and mineral products are very numerous, the collections of natural history objects deeply interesting, and the Art collection by no means unimportant.

In *British Guiana* we find samples of cotton-wool which have been pronounced equal to the finest Sea-Island; and we could describe much more that is interesting, did we not fear that the patience of our readers is already exhausted by this dry catalogue; we shall, therefore, hurry through our task and bring these remarks to a close.

The contents of the *Canadian Settlements* present every indication of a rising empire. The vegetable products of *Canada Proper* are of the most important and indispensable description. Winter wheat, weighing 66 lb. to the bushel, is shown with no little pride; and the enormous "trophy" of coarse woods sufficiently denotes the flourishing state of a trade which is being largely interfered with by the daily-increasing employment of iron in shipbuilding. This trophy itself is composed of enormous planks of oak, maple, birch, ash, elm, cedar, pine, walnut, cherry, and a number of other kinds, of which the names are almost unknown here; whilst the pedestal of the trophy consists of gigantic blocks or cross-sections of the same woods.

In the *New Brunswick* Court the same woods are exhibited in a very interesting manner. They form the leaves of a book, and are accompanied by the fruit and foliage of the various trees to which they appertain. Here, too, we have a valuable collection of furs, beaver-skins, &c.; and one of the chief attractions of the court consists of the beautiful pieces of furniture, cabinets, "what-nots," &c., constructed by the fair hands of the Canadian ladies, of "cone-work," in other words, with the cones of the fir-tree.

One mineral substance remains to be noticed in detail, and then we have done.

In this court is a most instructive series of samples illustrating the production, by distillation, of "Albertine oil" from Albert coal. We shall endeavour to convey by description some idea of the appearance of this useful substance in its various stages of manufacture.

First, then, we have the "Albert coal," a bright, light coal, somewhat resembling our "cannel." From this, a thick black fluid is extracted, which resembles crude petroleum, a greenish-black oil; this we will call No. 1. The next process, No. 2, leaves the oil solid, like clotted moist sugar; from this is produced No. 3, which presents a totally different appearance: it is a jelly-like mass, of a gold colour, and full of fine needle-shaped crystals. No. 4 is a thin liquid, resembling colza oil, but flowing more like a spirit. No. 5 may be compared to Irish whisky, being a thin straw-coloured spirit; whilst the last process, No. 6, brings us to the refined spirit, not unlike camphine in appearance.

Thus we have glanced cursorily at our most important colonies—have visited, in turn, New Zealand, the various parts of the continent of Australia; Ceylon and India, with their rich tropical productions; Natal, and the Cape of Good Hope; our West Indian settlements; and, lastly, the important districts of Canada.

Our review has necessarily been brief and imperfect, for we have had so large a mass of materials to consider—have observed such numerous indications of increasing wealth and prosperity—that, as we entered one court after the other, we were more and more perplexed to decide what appeared the most likely to interest our readers.

Let us repeat most emphatically, that, with one or two exceptions, the display is highly creditable to the exhibitors: not only evincing a spirit of enterprise, of which, as Englishmen, we should not boast over much, but an increasing intelligence and a progressive knowledge in science and scientific applications, calculated to astonish those who bestow upon them the consideration which they so richly deserve.

Long may our colonies continue to flourish! Long may they remember that this is the mother-country; but . . . (in this wish it is questionable whether we shall command such unanimous approval as in the two preceding) may they soon be sufficiently strong to govern themselves, so as to constitute the independent centres of civilization all over the habitable globe.

THE MISTLETOE AND PARASITIC PLANTS.

BY MRS. LANKESTER.

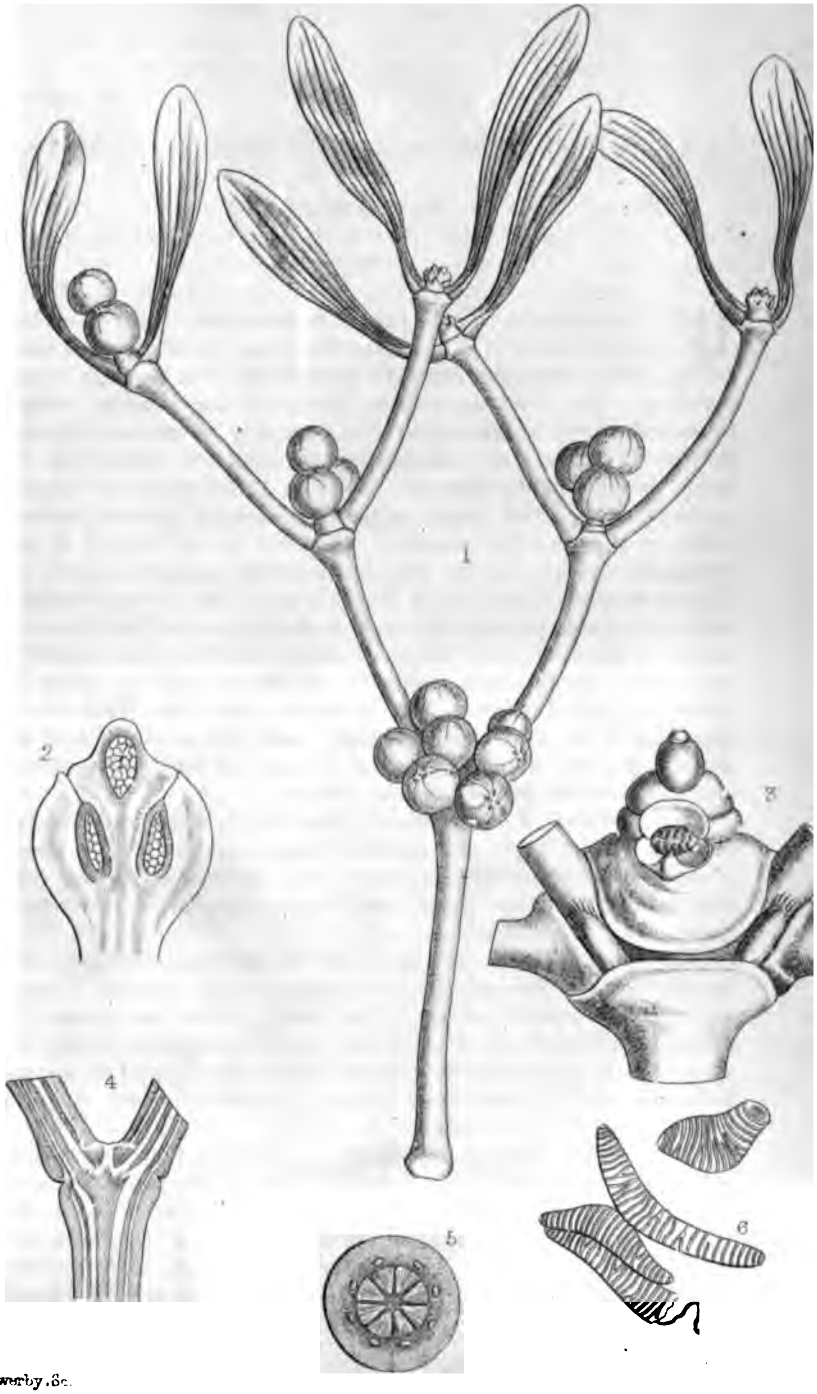
BUT few botanists would expect to prosecute their researches in the midst of Christmas fêtes and gambols, and even on specimens rescued from the lurid flame of a burning plum-pudding. Yet we can assure those of our readers whose botanical thirst is impatient for a supply of genuine spring flowers that no more interesting subjects for study can be found in the fields than the holly and the mistletoe—both, perhaps, associated more with the idea of indoor merry-makings than outdoor rambles. Neither are we limited in our botanical studies during the hard winter months, when all Nature seems hiding herself from observation, to these familiar and remarkable plants,—the coloured patches on the barks of trees, on old walls, and broken palings afford a whole world of interesting study; and beautiful collections may be made of these variegated lichens. We, however, select the Mistletoe as the subject for our "winter's tale," not only on account of its great botanical interest, but from its ancient and curious associations with the history of our country.

The Mistletoe, *Viscum album* (Plate VIII., fig. 1), may be regarded as the type of parasitic plants generally—of those plants which establish a habitation for themselves in the substance of some other plant, and live and flourish on nutriment drawn from this source.

The order *Loranthaceæ*, to which the Mistletoe belongs, and of which it is the only British representative, consists almost entirely of parasitic plants. But three genera are known in Europe. *Nuytsia floribunda*, an Australian plant, forms an exception to the parasitic nature of the species, and is a very beautiful shrub, with large bright orange-coloured flowers, which gain for it the name of *fire-tree*.

In describing the order *Loranthaceæ*, we find that some botanists have separated a number of plants once included therein, and established another order, *Viscaceæ*, of which *Viscum* is the type; *Loranthus* being that of the original order, *Loranthaceæ*. distinction is not very generally adopted, and we are garding our mistletoe as belonging to the family

Plate



J.E.Sowerby, Sc.

Mistletoe.

Loranthaceæ. The plants of this order have articulated opposite branches, leaves without stipules, and flowers in which the pistils and stamens are usually separated. The calyx is adherent to the ovary, with two bracts at its base, and the corolla consists of four or eight more or less united petals. The stamens are four or eight, opposite the petals. The ovary one-celled, with one erect ovule.

On examining a branch of mistletoe in the hand, we observe the long spreading stems of a yellowish-green colour, with somewhat thick, fleshy, long-pointed leaves, having veins running evenly along their entire length, most evident on the under surface. In the axils of these leaves, or the angle from which they spring, as also at the point where the spreading stems meet, we see, in the autumn of the year, a minute flower-bud—insignificant enough to look at, but of such interest, when examined botanically and carefully, as to have afforded matter for elaborate and beautifully-illustrated papers, which are preserved by the learned societies of this and other countries.

These flowers are divided into staminiferous and pistiliferous ones (figs. 2 and 3). The structure of these organs is very curious, and can scarcely be fully described in a few words, for authors differ as to the appropriate names and real functions of the parts. Schleiden, the great German botanist, supposes that the so-called male flowers consist of nothing but anthers; while Decaisne, of whose beautiful drawings in the Transactions of the Royal Society of Brussels we have, in a measure, availed ourselves, contends that the male flowers consist of four anthers grown to the surface of four calycine sepals. They grow on distinct plants from the female flowers, which are botanically the most interesting, as well as popularly, from the fact of their producing the beautiful white berries so characteristic of the mistletoe. The ovule at the base of the female flower does not appear at all until after the pollen has been shed from the anther in the male flower and has entered the little canal leading to the ovarium. Some weeks, or even months, after this has taken place, the little ovule or future seed makes its appearance, and, meeting with the pollen, commences to develop. At the same time, the viscous tissue, of which the fruit chiefly consists, begins to appear, and the tiny seeds are produced, which remain inclosed in their sticky, glutinous cradle until fully ripened and ready to reproduce their own kind. The fact of the ovule being produced after the pollen has exercised its influence is a curious deviation from the usual mode of development in plants. The structure of the woody tissue of the plant is also singular (fig. 4). Decaisne describes it, when young, as consisting of eight woody bundles surrounding a green pith (fig. 5); in these bundles are no spiral vessels, but instead, and in the place where they usually occur, are found some ringed tubes (fig. 6), together with some dotted or reticulated cells and fibres. On the outside of these bundles of woody matter, which form the longitudinal tissue of the plant, are found others, similar in number but smaller, and composed exclusively of fibres of the inner layer of the bark.

To trace these appearances a careful microscopic examination is required, and some of the more delicate observations cannot be conducted without first submitting the portion of stem to a saturation of spirits of wine.

The manner in which this curious plant establishes itself in the tissue of other plants is very remarkable, and has been well described by De Candolle in his excellent "Physiologie Végétale." Old botanists believed that birds, feeding upon the berries, and getting their beaks surrounded with the viscous matter they contain, rubbed their beaks against the branches to get rid of it, and thus introduced the seeds to their resting-place. Paley, in his "Natural Theology," gives at great length his views of the subject, and says :—

> Of no other plant can it be said that the roots refuse to shoot in the ground, and no other is known to possess this adhesive generative quality when rubbed on the branches of trees.

Careful botanists who have examined the process of growth in these plants from their earliest stage, tell us that from whatever cause the seeds are brought in contact with the wood of the tree on which they establish themselves, they adhere by means of the glutinous substance in which they have been embedded, and which hardens into a sort of transparent glue. Then two or three days after application the tiny radicle may be seen pushing towards the support, whether it be on the under or upper surface; reaching this point it becomes enlarged and flattened. It now has the appearance of a sucker, and by degrees penetrates the bark. This operation requires some time, and is not completed until the plumule begins to be developed. By the time the young plant has a pair or two of leaves, the attachment will be found tolerably firm.

Mr. Grifiths, who has written a paper on the Orders of *Loranthus* and *Viscum* in the Transactions of the Linnæan Society, tells us that on cutting away a portion of the branch on which the mistletoe had fixed itself and laying bare the included portion of the parasite, he found that the union had taken place entirely between the ligneous systems of both; the fibres of the sucker-like root of the parasite expanding on the wood of the support in the form of a web foot. There was, however, no interchange of structure between them, neither at this period was there any intermixture of ligneous fibres. As the parasite increases in size, and an additional supply of nutriment is required, lateral shoots are sent out from the surface, which also penetrate the bark, and are precisely similar in mode of attachment to the original seedling shoot. It is a curious fact that the fibres of the later shoots never penetrate further than those of their primitive attachment. In the adult plants the sucker-bearing shoots frequently run to a considerable distance; many of the stocks being literally covered with parasites, all of which have sprung from one seed. Mr. Griffiths says:—

> I have seen such shoots, which had taken their course along a decayed branch, become reflexed and return in quest, as I may express it, of a part capable of affording nourishment.

The remarkable exception which the viscum presents to the general law—that the radicle or root of the embryo shoots downwards and the plumule upwards, under all circumstances, has been confirmed by curious experiments. So certain is it that the radicle of the mistletoe will turn itself towards the body to which it is attached, whatever may be the position of that body with respect to the earth, that a cannon-ball, to which mistletoe seeds were glued on all sides, and suspended in the air, became the point of attraction for all the little radicles to direct themselves towards from all sides of the ball. This property insures their growing upon the branches of trees to whatever side they may happen to adhere. It is asserted that a branch of mistletoe, if placed in water, has no power of absorbing this fluid itself; but that when the branch to which it is attached is immersed, then the water is readily absorbed and penetrates into the mistletoe. The following experiment was performed by De Candolle. He immersed the branch of an apple-tree, bearing mistletoe, in water previously coloured red with cochineal, which, penetrating the wood and inner bark of the apple-tree, entered into the mistletoe, when its colour was even more intense that in the former. It would appear as if these parasitic plants had an eliminating power, for it is certain that they do not attach themselves to all trees or shrubs indiscriminately. Mr. Griffiths thinks, however, that they would grow on almost any plant whose duration is sufficiently long to allow them to establish themselves. Plants with milky juice seem to be an exception. The seeds of *Loranthus* have been seen to germinate on a frond of *Polypodium*. The influence these parasites have on the stock is according to their respective proportions. If they attack a small or weakly tree, they injure it, and perhaps kill it; but when they attack large vigorous trees, no ill results seem to follow.

The mistletoe is the only green parasite in this country; and often forms a conspicuous feature in the physiognomy of vegetation on the leafless trees of winter. It chiefly abounds on the apple, the pear, and plum tree; and I have also seen it on the poplar. Some authors say it grows on the silver-fir tree; but instances of its attacking the Coniferæ are very rare. Occasionally it may be met with on the oak, but its very unusual presence on this tree has probably much to do with the peculiar reverence with which plants found in this situation were regarded by our early ancestors, and their priestly advisers the Druids. In warmer countries, where the Loranthus grows, its scarlet flowers form a most brilliant contrast to the dark green leaves of the plant by which it is supported. In Chili a leafless Loranthus covers with a scarlet carpet a large candelabra-like cactus, whose snow-white flowers, eight or nine inches long, project from it, and present a beautiful object to the eye.

Parasitical plants, properly so called, are very numerous in the vegetable kingdom, although the species of *Loranthus* and *Viscum* alone have green leaves. There are parasites which live externally on their victims; others which are insidiously introduced into the interior, where they flourish until they pierce through the skin, come in contact with the air, and disseminate themselves. These are known by the various names of mildew, rust, smut, brand, &c. Those which attack externally assume different forms, and have either ordinary green leaves, as in the mistletoe, or brown scales and colourless stems. The brown scaly parasites attack the roots of plants, and their underground habits have caused them to be little examined. The most common species in Europe are the various kinds of *Orobanche*, broom rape, which attack hemp, clover, lucerne, and many other plants; and the species of *Monotropa*, birdsnest orchis, and *Lathræa*, tooth-wort, which infest the roots of the beech, the fir, and the ash. The best account of the manner of growth in brown parasites is given by Mr. Bowman, who studied with care the habits of the *Lathræa squamaria*. One of the most remarkable peculiarities of such plants is the constant absence of all green colour, though exposed to the strongest light. Connected with this is another curious property, that of resisting the attraction of light, towards which all the green parts of a plant irresistibly turn.

The Dodders also are true parasites, although they do not, like the mistletoe, plunge their roots into the wood and incorporate themselves with the tissue of another plant. Yet they twine themselves around the branches of trees, and send out suckers, which, becoming firmly attached to the bark, attract a sufficient amount of nutriment to support their tissue.

The dodders belong to the natural order *Cuscutaceæ,* and there are five species of dodder in Great Britain. The common English dodder is a white or reddish-looking annual, which spreads itself like a mass of living threads around branches of heath and furze, on dry wastes and commons. Unlike the mistletoe, the dodder springs originally from the ground, and when its little plumule first emerges, if it find no living plant near on which to graft itself, it withers and dies; but if there be one within reach, it surrounds the stem in a very little time, and henceforth lives by its suckers only on the fostering plant—the original root in the ground becoming obliterated and dried up. One species of dodder especially attacks the flax-plant; another the clover; and but lately in a meadow in Sussex, I saw most curious-looking masses of this clover dodder. It had attacked the growing clover in patches, which assumed the form of large rings or circles, and at a little distance it looked like carefully-arranged heaps of burned leaves or sea-weed; it was not until after close inspection that I discovered what this strange appearance was, and how terribly this intrusive plant had injured and despoiled the clover on which it throve. These parasites are very injurious to the plants they attack, depriving them of their nourishment and strangling them in their folds. Mr. Griffiths speaks of a gigantic species in Affghanistan, which even preys upon itself, and which half-covered a willow tree twenty or thirty feet high.

Of False Parasites or Epiphytes, as they are called, we have numbers of familiar instances in Great Britain. They generally fasten themselves in the crevices and hollows of the back of trees, and afterwards affix themselves so firmly, that they can only be torn away with considerable force. Lichens and mosses are of this kind. In humid atmospheres and in damp districts they are abundant, but in the warm moist woods of tropical regions they form a most striking feature in the landscape. On a single tree may be found such a number of different parasitic plants, as would cover a large space if planted in the ground. The Pothos plants then become parasitic and grow on the boughs of the loftiest trees, through whose foliage the large white flower rises. Strange Orchidaceæ and Bromeliæ, imbibing nourishment from the atmosphere, grow in the angles of the branches and fill up every crevice in the bark of the tree. The prettiest ferns, like our Lycopodium and Ivy, twine up on the surface of the trunk, while silver-grey Tillandsiæ hang from the branches; not to mention the multitude of climbers, which, once rooted in the earth, have ascended the trees and continue to flourish there when not a trace of their root remains. The long shoots of these plants often stretch from one tree to another, sometimes hanging like cords, more or less obliquely down to the ground, with not a single leaf for a distance of twenty or thirty feet—these serve for the monkeys and wild cats to clamber on. The parasitical vegetation of the tropics is wonderful in beauty and extent. The Orchidaceæ and Aroideæ are the most common on the barks of trees, and these in their turn are covered with parasites. As in the animal world so it is in the vegetable, every creature has its dependent parasite. We may be excused for quoting a not very elegant, but an expressive couplet:—

Large fleas have little fleas upon their backs to bite 'em,
And little fleas have lesser fleas, and so *ad infinitum.*

Microscopic examination alone can reveal to what extent this law of mutual dependence is carried out in every living form. It is not only, however, in living vegetation or animals that we discover parasites. Several kinds are known to exist alone on dead organic bodies. The decaying trunk of a tree affords numerous examples of this sort of parasite, and the German botanist Schmid distinguishes wall, ruin, roof, plank, and rubbish plants. Others of the fungus kind grow only in the strangest situations: such as on wine-casks, in window panes, and on paper. But it is impossible to enlarge on this attractive subject, which would form a paper of itself, whilst we have our branch of Mistletoe for a text waiting for further notice.

The fact that this curious plant is bright and green when all Nature is wrapped in her winter mantle may account for its constant association with Christmas festivities and decorations. Then it has the attraction of association with bygone times and ages. Christmas itself is not now what it used to be in the days of the old Tudors, who, with their maskings and revellings, seem to us somewhat coarse in their boisterous merriment. With our increasing refinement we have lost perhaps some of the spirit of the season, and we believe almost the only relic of the ancient license of the occasion lingers still in some remote country-houses, and in the servants' halls of the present time. John still thinks himself at liberty to kiss Mary under the mistletoe, and the overhanging shadow of the mysterious plant saves Mary's blushes. The superstition connected with the mistletoe is in its character something like that which surrounds the four-leaved shamrock. St. Patrick's touch sanctified the one, and the association of the other with our country's earliest priests—the Druids—has hallowed its history. The doctrines inculcated by the Druids were, ny respects, far in advance of the people by whom they rounded. They regulated all religious services and were the ministers of many things, both secular and sacred. They worshipped many of the Roman deities, and regarded the oak as a sacred tree. Under its shadow they performed most of their sacrifices, and no religious ceremony was entered upon by them without wearing a garland of its leaves. The mistletoe growing on the oak received from them the same homage as the tree itself. The ceremony of cutting the mistletoe from the oak is described by Pliny, and seems to have been the occasion for a great religious festival. It took place as near the 10th of March in each year as possible, and was performed by the Arch Druid himself, who, having tied two white bulls to the tree by their horns, then mounted the tree, clothed in white, and with a knife of pure gold separated the mistletoe from its parent tree, which was received in a "white sagum," or cloth made of wool; this done, the bulls were sacrificed, and they proceeded to the further observances and feastings. Our own national custom of decorating our churches and homes with mistletoe at Christmas time may be a remnant of this old superstition. Moreover, it would appear that the Druids were the medicine-men of the time, and in their prescriptions the mistletoe was a frequent ingredient to be taken with incantations. Pliny tells us they had a name for it equivalent to *All-heal*, and it was esteemed peculiarly good in epilepsy or falling sickness. This reputation does not seem to have disappeared with the Druids; for, although some of the ancients looked upon the mistletoe as poisonous, the old herbalist Gerarde, in 1636, gives his opinion as quite the reverse, and says—

> A few berries of the mistletoe, bruised and strained into oile and drunken, hath presently and forthwith rid a grievous and sore stitch.

He also quotes Galen, who says—

> His acrimony overcometh his bitterness, for if it be used in outward applications, it draweth humours from the deepest and most secret parts of the body, spreading and dispersing them abroad and digesting them.

We are inclined to think that the imagination of the patient had more to do with the efficacy of the mistletoe plasters, as it has with many modern and still favourite remedies, than any virtue in itself. The only practical use to which we now apply the berries of the mistletoe is in the manufacture of birdlime.

Much discussion has taken place as to whether the Loranthus or *Viscum album* was the true mistletoe of the Druids. To my mind there can be but one conclusion in favour of the latter. Loranthus does not naturally grow in Great Britain, and the true mistletoe, *Viscum album*, as also its fostering oak, are strangers in the land where Virgil sang of the golden bough which formed Æneas's passport into the infernal regions. His bough was undoubtedly one of Loranthus, not of our own true British mistletoe. May we never cease to find it green and bright on our orchard and forest trees, though they be leafless and bare, adding to the delight of our winter walks and our household merrymakings, and may every reader of this little paper henceforth find in a spray of mistletoe a deeper interest, both scientific and historical, than he has ever done before.

Fair Plant, a mystery thy birth,
Thou dost not fix thy home on earth ;
Rock'd by the winds, fed by the shower—
Thy cradle is an airy bower.
No voice of crime in thy leafy dome,
But the songs of birds to cheer thy home,
From the wildling crab this branch was riven
From waving in the breath of heaven.
Alas, alas ! they have brought it low,
To the dwellings of care, and pain, and woe.

PROFESSOR HENSLOW.

EXPLANATION OF PLATE VIII.

Fig. 1. Branch of mistletoe, in fruit.
Fig. 2. Vertical section of an antheriferous or male flower.
Fig. 3. Female flower in the axils of the leaves and branches.
Fig. 4. Vertical section of a branch two years old, showing the tissue.
Fig. 5. Transverse section of the same branch.
Fig. 6. Vessels forming the ribs or nerves of the young leaves.

THE WINTER LIFE OF PLANTS.

BY HARLAND COULTAS.

THE Winter landscape is now spread before me. Every day the field of white snow-drifts which caps the Northern portion of our globe is extending at its circumference. The trees are deprived of their summer foliage, and the race of hardy evergreens appears to advantage. Only here and there a solitary late-blooming flower may be seen, and this at last disappears under the white snow-covering. Nature appears to be devoid of life, as though her pulse had ceased to beat; and we are almost ready to imagine with the poet that the snowy mantle is a pall or winding-sheet thrown over her inanimate and motionless form. Never was there an idea more erroneous. The same formative laws which give to the falling snow-flake its beautiful crystalline forms still operate in the plant-world.

We must, however, except the vegetation within the Arctic circle. The people there never see the sun for months, and without his influence the vegetable machinery will not work. It is, therefore, probable that the Polar plant-world, in all its forms, is in a complete state of torpor and inactivity in winter, during the sun's absence.

But, in lower latitudes, where the sun continues for a few hours above the horizon in winter, his rays are always diffusive of life, however obliquely they fall on the landscape. In all the lower forms of cryptogamic plants there is a considerable amount of active vegetation going forward. Mosses, liverworts, and lichens are very retentive of life, and will grow at very low temperatures—even beneath the snow and ice with which they are covered, provided it is not too deep, so as to prevent the light from getting access to them. Many mosses and liverworts ripen their sporangia or come into fruit in winter. And, as for the lichens, winter is their vegetating period. In summer they are torpid and inactive. Lichens have been very appropriately named by Endlicher, *Protophyta,**

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* The term *Protophyta* is now, strictly speaking, applied to the very simplest plants, such as *Protococcus volvox*, &c. &c., and not to the Cryptogamia.

or first plants; because they are the very first plants which gain a foothold on the barren rock, and, dying there, prepare the way for a higher vegetation. At this season of the year, when the landscape is no longer decorated with flowers, the moss- and lichen-covered rock has a peculiar interest attached to it, of which it is deprived in summer. There grows the vegetation of winter; and our attention is no longer turned away from these lowly protophytes by the more gorgeous and showy plants which surround them in warm weather.

All the year round there is ceaseless activity in Nature. Plant-life never expires. Even in the depth of winter, there is much organic beauty abroad. Choose your time judiciously, when the sun is up and the weather is clear and frosty, and, if the snow is not on the ground, you will find good botanizing even in winter, if you attend to mosses. You will find these plants almost everywhere. On rocks, fallen trees, on the banks of rivulets, or on the surface of the stones in their pebbly beds; and, if you have a microscope and "Hooker's British Mosses," where these minute plants are most beautifully figured, you will be at no loss for amusement.

But the active portion of vegetation is not wholly cryptogamous. In the strongest January frost, the trees of the mountains—the noble and hardy firs and pines—ripen their seeds. These trees abound in resin, and maintain their temperature above the freezing-point even in the severest weather. Their fluids are never congealed, owing to their viscidity, and they can, therefore, resist the cold. The sap continues to ascend in them, although its upward flow is very considerably diminished.

There appears, also, to be some continuance of vital activity amongst the evergreens which bear true leaves—such as the ivy, laurel, and holly. From the very nature of things, these plants must change their leaves; but they do it in a less rapid and visible manner than the deciduous-leaved trees, one leaf replacing the other in such a way that the tree is never totally deprived of foliage. In the spring of the year there is a partial leaf-fall from the branches of evergreens. The leaves of these plants are more or less in action during winter.

A low degree of warmth will, even in the depth of winter, start the sap of plants. Thus, if incisions be made into the stem and branches of a young maple in winter, if the weather should become mild, the sap will be seen to trickle from the wound.

As a general rule, however, winter is a state of repose to all the higher Phanerogamia or flowering-plants, the only really active portions of vegetation being [illegible] lines, Evergreens, and the lower orders of the [illegible] if these higher flowering-plants manifest no active life-processes during their winter's slumber, one process is as absolutely necessary to their preservation as to their growth—there must be an interchange of matter between the air and the body of the plant. This exchange may be small, but it is more than probable that it to some extent exists; for it is a law of plant-life that it can only exist so long as evaporation and breathing are carried on. In winter the inside of a tree, examined with a thermometer, shows a higher temperature than that of the surrounding atmosphere, and this warmth is a proof of vital changes. Although in the development of most deciduous-leaved trees and perennial herbaceous plants, winter is a state of rest, yet they retain their vital properties, and it is no more a state of *absolute* inactivity than the healthy sleep of the animal body, with which this winter's repose of vegetation may be very properly compared.

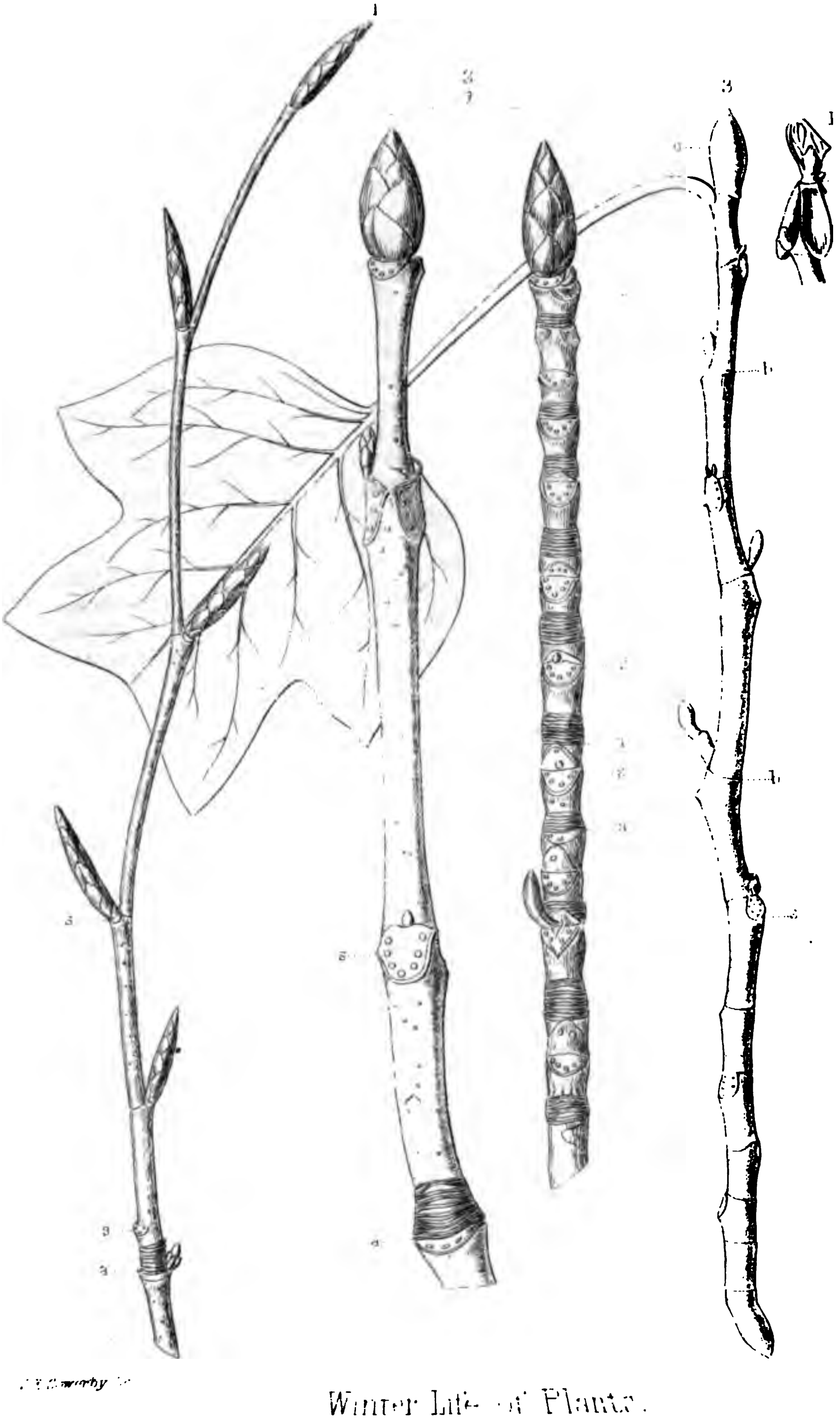
Even those trees which are apparently devoid of foliage, still possess leaves. We refer to the scales or covering leaves which constitute the outer envelopes of the buds. These are the winter leaves of trees, and each tree has them quite as characteristic of its species as its summer leaves. That the scales of buds are only modified leaves, every botanist will readily allow. In many plants the transition of the bud-scales into ordinary green leaves is well marked; and that they are varieties only of the same common leaf-forms, is also indicated by their spiral arrangement, and by the fact that they are alternate or opposite in position about their rudimentary axis, exactly as the leaves may happen to be arranged on the fully developed shoot. These bud-scales or covering-leaves must be regarded as the very lowest type of leaf. They begin to form in spring, and continue growing through the whole of the summer. During the active period of vegetation the current of sap is diverted away from them by the summer leaves, so that they cannot make much progress. In autumn the sap gradually ceases its flow towards the summer leaves, and its last movement, before it stagnates in the tissues, is probably to these winter leaves or bud-scales; for it is then that the buds are matured, just before the trees shed their summer leaves in autumn. Hence physiologists have very properly designated as autumnal sap this peculiar flow of the stagnating nutritive current. The winter leaves being formed under such circumstances, are necessarily circumscribed to the smallest space, and as they do not take the conspicuous forms of the summer leaves, they escape vulgar observation.

These winter leaves of trees, so apparently insignificant, will, however, richly repay investigation. The tree requires protection, not nutrition, in winter, and these leaves are organized for that purpose. They are devoid of chlorophyll or leaf-green, and without pores. In some instances their surface is clothed more or less densely with hairs, or it is covered with glands which exude a copious resinous or glutinous secretion, with which the surface of the bud is overspread. These leaves are thus organized in order that they may protect the next year's foliage, blossom, and fruits. All the beauty and glory of the vegetation of the coming year is left in the charge of these inconspicuous bud-scales or winter's leaves; for every leaf and blossom is already formed and securely packed away into the smallest possible space in these buds, under the air and water-tight roofs formed by them. In order to verify these facts, it is only necessary to dissect one of these buds, by removing its scales, and examining the embryo leaves in its interior with a microscope. The bud of the horse-chestnut is one of the best that can be selected for this purpose. The embryo leaves will be found in the interior of this bud, in a warm bed of tomentum or down, packed away securely for the winter.

The winter leaves or bud-scales continue attached to the trees throughout the winter months; but when spring comes, and the summer leaves which they have protected are pushed out into the air, the tree shakes off its winter leaves on the green grass carpet, exactly in the same way as it does, later in autumn, its summer leaves. So from all the trees of the forest there is every year a double leaf-fall. The fall of these winter leaves is beautifully seen in the beech, maple, and horse-chestnut; and, as we have already remarked, an observer of nature will experience no little gratification in studying these little obscure though important folioles. The bud was called by Linnæus the *hybernaculum* or winter-quarters of the shoot; and buds with the winter leaves on their exterior may also be regarded as their winter defences. The winter leaves are organized to protect the life slumbering in the buds against the cold of this season of the year. A low temperature appears to be necessary to their life, for as soon as the warm days of spring commence and the summer leaves come out, they fall from the tree. These winter leaves cannot, therefore, live under the same circumstances as the summer leaves; and the winter atmosphere in which they live and discharge so faithfully their protective duties to the summer leaves would destroy the life of the latter.

As the summer leaves make on the stem a cicatrix or scar which shows their former point of union, so with the winter leaves; these also leave their mark or scar; only in this instance,
nodes or naked intervals of stem between the leaves
d, the scars are necessarily close together, and

Plate I



J.E. Sowerby sc.

Winter Life of Plants.

form a series of annuli or rings, for which botanists have no name, and which we have ventured to call (*gemmæ vestigia*) vestiges of buds. Whenever these rings are found on the bark of young shoots, they show the position of the winter leaves and the terminal bud of the season,—in fact, the point where the growing shoot entered on the stage of rest. Hence the interval of shoot between two sets of bud-rings shows one year's growth; and therefore the number of sets of annuli shows the age of the shoot.

The reader will better understand our meaning if he will look at the plate which accompanies this paper.

Plate IX., fig. 1, represents one year's growth of the beech-tree (*Fagus sylvatica*), with five buds and their spirally arranged scales or winter leaves. The cicatrix or leaf-scar *s*, left by the summer leaf, is visible at the base of each bud; and the annular scars left by the winter leaves of the previous year are to be seen at the base of this shoot, marked *a*.

These parts are more conspicuous in fig. 2, which shows two shoots of the horse-chestnut tree (*Æsculus hippocastanum*), one the growth of a single year, the other the growth of ten years; yet both shoots are nearly the same size. We have placed them together for the sake of comparison.

The leaf-scar *s*, left by the nutritive summer leaves, is very large in the horse-chestnut, and on its surface are seven black dots, the broken ends of the fasciculi, or bundles of woody fibre, which, uniting together, form the leaf-stalk, and, separating again at its top, form the costæ or midribs of the seven leaflets. This tree derives its popular name from the resemblance of its leaf-scar to the shoe of the horse, those black dots corresponding with the nails in the shoe!

In the ten years' shoot it will be seen that there are on the scars of the summer leaves only five dots; consequently there were only five leaflets to each leaf. The contrast between the broad open scar left by the summer leaves and the contracted ring-like scars of the winter leaves, is in this instance very striking. It is also evident that the vegetative power of the ten years' shoot was ten times less each year than that of the one year's shoot; because it has taken this shoot ten years to make a growth equal to the growth of the one year's shoot. As the growth of the shoot depends on the matter derived from the leaves, and as in this case very little was supplied, the shoot itself is cylindrical, not conical, like the one year's shoot.

Fig. 3 is a twig of the tulip poplar (*Liriodendron tulipifera*), one of the forest trees of North America. The leaf-packing in this bud is peculiar and interesting. *c* represents the closed stipular bud; *d*, a stipular bud opened, with the two stipules reflected downwards, to show the inverted position of the lamina or blade of the embryo leaf *l*, the two sides of which are folded together and which is bent downwards on its petiole. Behind is another stipular bud consisting of two stipules inclosing another inverted embryo leaf. Further dissection reveals other embryo leaves on a constantly diminishing scale of architecture, *b*, the linear mark on the shoot, or scar made by the stipular leaves, which are, in fact, only another variety of winter leaves. There are seven dots on the leaf-scar.

These shoots were collected in autumn. The *Liriodendron tulipifera*, which is a deciduous-leaved tree, has still attached to its apex one of its leaves, which is purposely left there, in order to give the reader a correct idea of its peculiar truncated form, and also a clear view of the embryo leaf *b*.

The lower and less developed herbaceous plants have also a winter's life and an appropriate shelter for that life, as well as the trees. The seeds of annuals and also the rhizomes, or underground stems of perennials, like the buds of trees, are only so many winter retreats into which the exhausted life of these plants retires for protection, repose, and recuperation during the winter months. "Seeds and resting-spores," says Henfrey, "are organized in a manner especially adapted to preserve their latent vitality from injury by external influences. They can withstand great variations of heat or cold, especially in the absence of moisture. Most seeds will bear a temperature very far below the freezing-point if kept dry, and many will bear an exposure to 100° or 110° Fahr. in dry sand. Prolonged immersion in water at 120° kills most seeds unless the skin is very thick and they contain oil instead of starch in their endosperm."

The seeds of the Whitlow-grass (*Draba verna*), of the different species of chickweed (*Cerastium* and *Stellaria*), of the fumitory and corn-cockle, are sown early, and are, therefore, exposed to the excessive heats of summer as well as to the cold of winter, and yet they come up at their appointed season. So carefully has Nature prepared the seeds of these plants for the vicissitudes to which they are exposed! *Draba verna*, for example, is never scarce. This plant is quite common in Pennsylvania, as well as in England. There is no flower which has interested the writer more than this lowly annual. It is one of the least developed of all the Cruciferæ, whether we consider its leaves, whose vegetative power is so enfeebled that they do not form a sufficient amount of stem to separate them from each other, but remain in a stellate cluster on the ground; its tender capillary scape, or flower-stem, which only rises to a height of from one to three inches above the ground; the two or three small white flowers which that scape supports; or the brevity of its life, for it comes up in March, and by the close of April has matured and scattered its seeds. Yet these minute seeds, with their microscopic rudiment of a plant, are mixed with the soil, from which they cannot be distinguished, and after lying exposed alike to the heat of summer and the cold of winter, germinate again at the appointed time on our rocks and old walls. In Pennsylvania, where the extremes of heat and cold are much more severe than in England, *Draba verna* grows profusely, and the writer has seen the gneiss rocks about Philadelphia positively overspread with whitened patches of this little plant, towards the close of the month of March.

But the greater portion of the herbaceous plants are perennials, whose leaves and flowers annually die down to their rhizome or underground stem, and, therefore, disappear like the annuals from the earth's surface in winter. But life remains in the rhizome, and the next year's growth is contained within the buds on the surface. The soil in this case shelters the buds. Hence, as soon as the frost is out of the ground, the plants which have been thus protected, issue forth from these subterranean buds, push up through the soil into the atmosphere, and again unfold their leaves and flowers on the same spot. Perennial plants, having the rhizome and bulb as a means of self-preservation, as might be naturally supposed, are not so prolific in seed as annuals.

The period of seed-rest or vegetable torpor may be prolonged for years, if there are not the conditions necessary for germination. For sixty years a bag of plants supplied the "Jardin des Plantes" annually with sensitive plants. Lindley mentions the germination of raspberry seeds, found in 1834, in an ancient barrow (*tumulus*), near Maiden Castle, along with coins of the emperor Hadrian. The seeds were found in a coffin thirty feet below the surface, and may have been from 1,600 to 1,700 years old.

It is thus that the germs of vegetable life are preserved. The Winter-life of Plants! It is one of slumber and inactivity, comparatively speaking, yet how deeply interesting its preservation. What, though the trees have on at present only their plain unattractive garb of winter leaves, yet their more ornamental summer-leaf dress has been carefully prepared for them, and now lies folded up in the bud,—the wardrobe of Nature! They will put it on uninjured at the appointed time! What matters it that the fierce north winds sweep the landscape of all its visible life and fertility, and extend still farther and farther the snowy territories of winter? The flowers are all safely sheltered in their winter home, beneath that snow covering, either in seeds or underground buds, and they will come up again in their old haunts, delicate, beautiful, uninjured as ever! Who thus protects folded leaves and sleeping flowerets?

Even in winter, Nature with unwearied hand is ever preparing food for her plant-children, when they shall awaken from their slumbers. Frost and snow are of great service: the former breaks the hard masses, and renders the soil loose and porous; the latter spreads a warm covering over the landscape, thus protecting the numerous seeds of annuals and the underground stems of the perennials. Snow contains ammonia and other nutritive gases, and when it melts, the plants drink in its nourishing constituents. Thus when winter covers the earth with snow-storms, Nature is really benevolent, although apparently stern and unpitying.

EXPLANATION OF PLATE IX.

Fig. 1. One year's growth of beech-tree (*Fagus sylvatica*).
  a. Annular or ring-like scars, left on the bark by the winter leaves or bud-scales.
  s. Cicatrix, or leaf-scar, left on the bark by the summer leaves.

Fig. 2. Two shoots of the horse-chestnut tree (*Æsculus hippocastanum*) placed together for comparison. The left-hand shoot is the growth of a single year, the right-hand shoot is the growth of ten years.
  a. Scars left by winter leaves.
  s. Scars left by summer leaves.

Fig. 3. A twig of the tulip-poplar (*Liriodendron tulipifera*).
  s. Cicatrix, or leaf-scar, left by the summer leaves.
  b. Linear scar left by stipular leaves, a peculiar modification of the winter-leaf.
  c. A closed stipular bud.
  d. An open stipular bud, with the two stipules reflected downwards, to show—
  l. The lamina or blade of the embryo summer leaf inverted on its petiole, or its position whilst inclosed or packed away within the stipular leaves.

THE VINEGAR EEL

(*Anguillula Aceti*).

BY JABEZ HOGG, F.L.S., ETC.

AS much doubt seems to prevail concerning the development of the Anguillula, it appears to me a short history of these curious members of .the animal creation will not be out of place in the pages of this Journal.

It was at one time believed that vinegar eels were produced " in vinegar only (as stated in foot-note, at page 501, POPULAR SCIENCE REVIEW, July), without the addition of any kind of vegetable matter ;" but modern means of research have greatly contributed to our knowledge of these as well as many other minute creatures. The microscope, assisted by chemistry, has exploded the old idea and demonstrated to our senses that scarcely a liquid or a solid is free from the attacks of one or other of the many varieties of fungi, the sporules of which, ever floating about in the air, are everywhere present, and ready, in some marvellous way, to initiate the work of either reconstruction or destruction, as the case may be.

A vast number of these fungoid growths are developed in fluids during the various processes of fermentation ; if, indeed, it may not be said of them, that they are the principal active agent in these apparently spontaneous reactions ; all having a hidden period of incubation in these fluids, during which unseen stage they are causing the chemical changes in them, until finally a cryptogamic plant appears, multiplied a thousandfold, with each of its millions of sporules endowed with the original capacity of producing the same changes in the next fluid into which it may chance to enter.

We observe, also, another peculiarity in these low forms of vegetable life,—the remarkable facility they possess of assuming other forms and characters, which would appear to depend upon the nature and constitution of the fluid, soil, and habitat in which they were found. This fact led me to *the probable conclusion*, in my late paper on the Truffle, when noticing the ciliated motion before Anguillulæ made their appearance in the sour mass. I am now anxious that it should be known, that, upon making further examinations, I have not been able to verify the presence of cilia upon the ova; so that I believe the action observed must have been due to the presence of some other minute animal or vegetable life; as vibriones, &c.

If we now turn our attention particularly to the development of the Anguillulæ, we shall find they constitute a very widely distributed family, belonging to a still larger order of the animal creation,—the Nematoidea, which abound almost everywhere. The whole genus were formerly classed with Infusoria, and arranged under variously distinctive names, mostly determined either by the substance or situation in which they were first discovered. The earliest contribution to the natural history of Anguillulæ appears in the writings of Turbervil Needham, under the heading of "Microscopical Observations on the Worms discovered in Smutty Corn," published in the year 1744, in a paper contributed to the Philosophical Transactions of the same period. He very correctly describes these *worms*, as he called them, and their economy, illustrating one memoir by tolerably correct figures. Yet, in a subsequent paper, he most unaccountably retracts everything he before had written respecting them, and declares "the white fibrous creatures in the interior of the corn to be true zoophytes."

Maurice Roffredi, in his memoir "*Sur l'Origine des petits Vers ou Anguilles du Bled rachitiques,*" which appeared in vol. v. of the *Journal de Physique*, 1775, fully describes the Anguillulæ. He seems to have attentively observed their whole economy and many other peculiarities in the various stages of existence, although he fell into some errors with regard to their early development in the corn. He also was the first to communicate, or "enoculated," as he terms it, the disease to rye and barley, by transferring young eels to both these grains, and in which they became as quickly developed as in wheat grains.

F. Fontana also published some remarks on these minute creatures in 1776; but he fell into many errors concerning them: first, he maintained that the infected grains in which the eels are found—

> Are extraneous tumours, or gall-nuts — the mere produce of the worms; and, secondly, that the suspension of life, or muscular action, is neither a state of torpor nor suspension, but real death or extinction of life; and that they are brought to life again as often as they are moistened with water.

But the clearest and most trustworthy account of the Anguillulæ appears in the Philosophical Transactions of 1822, by a Fellow of the Royal Society, Francis Bauer, in a memoir "On the Muscular Motion of the *Vibrio Tritici*;" and the point which struck this observer most,—indeed first led him to study them, was their remarkable power of life. He commences by telling us, what now is well known, that—

> This minute animal is the immediate cause of that destructive disease in wheat known by farmers under the name of ear-cockle or purples. On opening some of the diseased grains, I found there the whole converted into a mass of white fibrous substances, apparently cemented together by a glutinous substance, and formed into balls, which could easily be extracted entire from the grains; and which, when immersed in water, instantly dissolved, and displayed in the field of the microscope, hundreds of perfectly-organized minute worms, all of which, in less than a quarter of an hour, were in lively motion.

Having left some of them on a glass for some four or five days, they were dried up and apparently dead; but upon again moistening them with water, much to his surprise, in a very short time they began to show signs of life, and in the course of an hour were as lively as before. This experiment he made again and again, with the same results; but found that those which had been kept the shortest time under water recovered their motions soonest; so that, after a second or third suspension, at intervals of a week or ten days, they could not be revived.

> If, however (he says), the second experiment be not made too soon after the first, the chances of recovering are greater. The longest interval, after a second suspension of life, I was able to recover them, was eight months. If, when first revived, they are kept in water, excluded from the air, and evaporation prevented, they remain alive and propagate for many months.

Their eggs have an extremely delicate transparent shell or structureless membrane, through which the young can be attentively observed. With some care it may be seen moving within its envelope, and, by a spinal motion, at last breaks through and escapes. The egg measures about the $\frac{1}{300}$th of an inch in length; and soon after the young animal quits the shell, it shrivels up and disappears.

Each single grain of corn contains many eels. Bauer found in one—

> Seven full-grown and a hundred young eels, all alive, beside a great many eggs; and, upon being placed in water, they were seen twisting and wriggling about, like so many serpents.

He experimented upon grains, after keeping them for five years and eight months, and always with the success narrated; but he found the corn required to remain under water a much longer time before the eels were resuscitated. When they die, they remain in water, unaltered in form and character, for many days or weeks.

He supposes the glutinous substance which surrounds the eels, when he cut open the corn,

> Must be secreted by them; since, in the infected grains, the cellular tissue has entirely disappeared. From this fact, we may consider that the glutinous substance preserves the young animals from further change; and what is recorded of the snail, which can, by its own mucus, hermetically seal itself for thirty years in its shell against a wall, is similar to this.

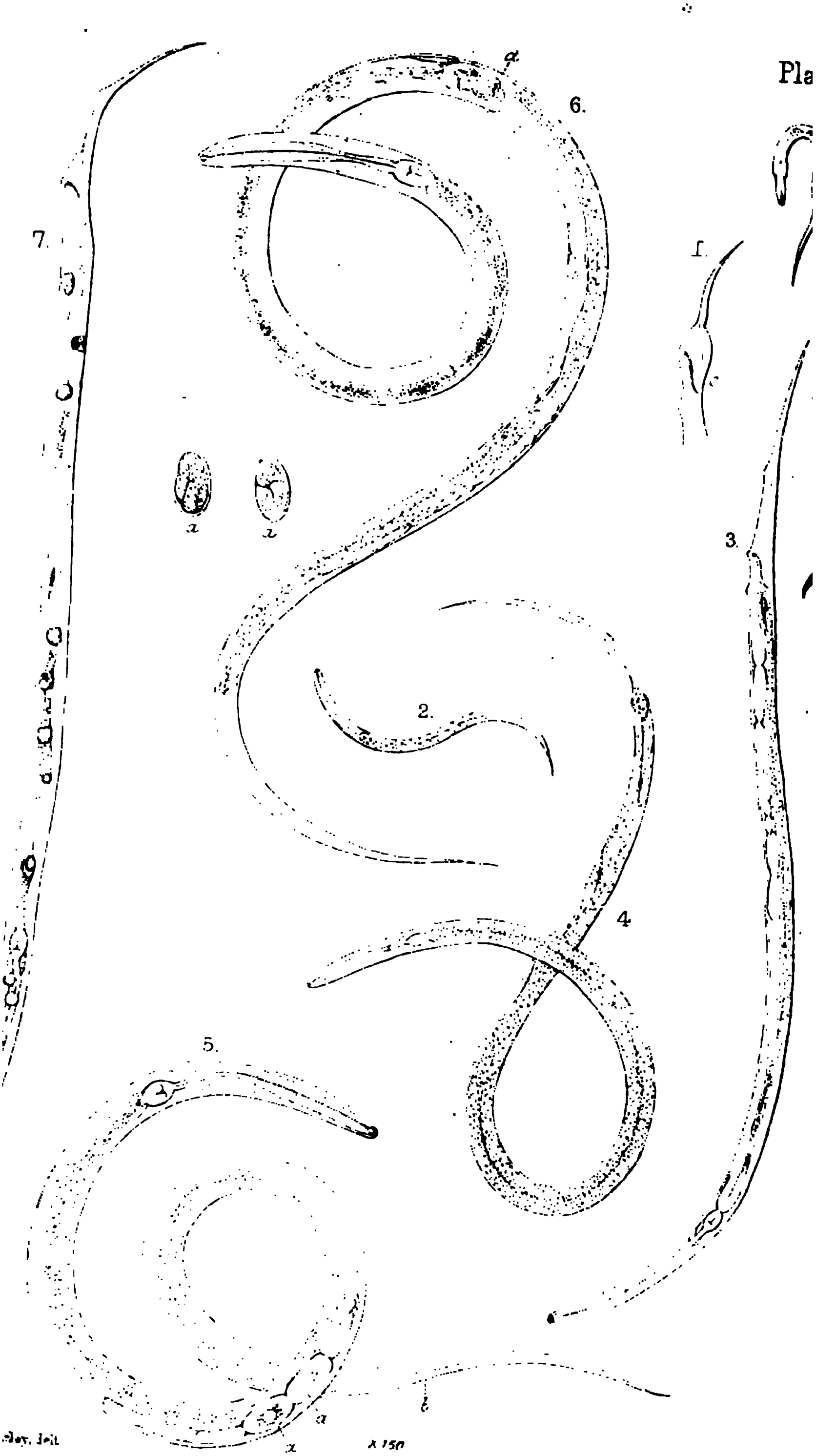
I have resuscitated them after the infected corn has been allowed to lie excluded from light and air for upwards of eight years. Indeed the whole of the species are most remarkable for their great tenacity of life, resembling in this particular the Tardigrada and Rotatoria.

The various species of the Anguillula most familiar to microscopists are—1st, *Ang. Tritici* of blighted corn,—wheat, &c.; 2nd, *Ang. Aceti,* of vinegar, or in any substances undergoing acetous fermentation; 3rd, *Ang. Glutini,* of sour paste, so precisely similar to *A. Aceti,* although authors still persist in describing it as distinct, is nevertheless exactly the same in every particular; and 4th, *Ang. fluviatilis,* found in waste waters among the decaying vegetable matters, as well as in wet moss, boggy districts, and moist earth.

It will be observed that wherever the Anguillulæ have been found, they are invariably developed in, and probably live upon, the decaying vegetable substances. The ova of these creatures are so minute, that when the earth or vegetable matter is dried up and converted into fine dust or powder, the wind takes it up, and it is driven about hither and thither over the face of the earth. The microscope has failed, as yet, to demonstrate the presence of ova mixed up with earthy or vegetable matter, before it becomes infused into the liquid material, which swells out the mass, and calls it into new life and vigour. Yet that the ova must be present, no reasonable mind can doubt, as we soon discover some chemical change going on, and suddenly the whole is converted into colonies of living eels; and such is the tenacity with which they cling to life, that no amount of exposure to either heat or cold, or other climatic influence, is able to entirely extinguish it.

Thus, it appears, from the observation of trustworthy observers, that *Ang. fluviatilis* have been exposed to the scorching heat of a summer's sun, until perfectly converted into the finest powder or dust; nevertheless the first gentle shower of rain descending upon some of this at once begins to swell it up, softens it, and, finally, creatures sporting in the sunshine appear in all stages of growth, taking food, and exercising all various functions of the higher-organized animals. What more extraordinary is, that some of them delight in

Pla



The Vinegar Eel

strongly acid or corrosive liquids, such as would be poisonous to most other creatures. It may in reality be said of them that they live only in substances unfavourable to life in most other animals.

The *Anguillula Aceti* is only found in the inferior and diluted vinegars of commerce. In the strongest vinegars sent out by manufacturers of repute, it never occurs; the reason of which is, that considerable care is taken to separate all mucilaginous or albuminous vegetable matters from the acid. This is effected by certain refining processes, as well as by the addition, allowed by law, of a certain quantity of oil of vitriol (sulphuric acid) to every gallon of vinegar, before it is sent out to the retailer. The legal quantity of this strongly corrosive acid is often exceeded in the commoner or badly manufactured vinegars; otherwise they would rapidly spoil, and generate the vinegar eel, and become mouldy, or mothery, as it is more commonly termed.

Dr. Hassall found that many other ingredients are used in the adulteration of vinegar; and in eighteen samples out of twenty-eight examined by him, he found not only a larger proportion of the oil of vitriol than there should have been, but also remains of vegetable and other matters, some of which were positively of a deleterious nature. Nevertheless, in a very short time, all were soon more or less covered over by some fungoid growth. From this fact we may gather that very great difficulty is experienced in preventing the vinegars of commerce from undergoing rapid decomposition; doubtless arising from the facility with which the sporules of fungi, as well as other organized bodies floating about, find a ready access to the fluid, and which appears to afford all the required elements for development and growth.

Although well known that water is rarely if ever found free from the presence of either living or decaying vegetable matter, we were, perhaps, not quite prepared to find another fluid, having a large admixture of a strongly corrosive acid, and which at first sight might, without much hesitation, be pronounced noxious to the growth of either vegetable or animal, offering a suitable nidus for the development and nourishment of both; and we at once see that it would be quite at variance with facts to say that vinegar eels "are developed in vinegar *only*, without the addition of any decaying organic substance."*

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* The foot-note twice referred to in the course of this paper is our own: and our readers might be disposed to infer that there is a difference of opinion between the author and ourselves. This is not the case. When we spoke of "vinegar only," we referred to the addition of slices of truffle, and

The accurate drawing of the vinegar eels made by Mr. C. Whitley for this paper, so faithfully portrays the little creature in its several phases of life, that it appears unnecessary to add anything by way of further description. It may, however, not be uninteresting to add, that this minute and curious eel is not unfrequently made the means of practising upon the unwary a gross but very characteristic imposition by the advertising quacks who infest this great metropolis. A victim offering himself to be fleeced is usually received in a well made-up room, lined by book-cases and illuminated diagrams of the organic structures in the human body, healthy and unhealthy. Instead of the old-fashioned stuffed alligators suspended from the ceiling, the Paracelsus of modern times ostentatiously parades the most showy and expensive microscope obtainable, in closest consultation with which he takes care to be found by the patient, just as an *ant-lion* may be supposed to be studying nature as he reposes at the bottom of his conical trap, the sloping sides of which, made up of the finest sand, prove a very *facilis descensus* to his unsuspecting prey, who ventures on the treacherous surface. Proceeding to business after some preliminary anxious inquiries, *the doctor* (!) gravely proposes to aid his diagnosis by that crucial test, the microscope. The dismay of the poor victim may be more easily imagined than described, when, on being pressed to see for himself, the state of affairs is revealed to his agitated mind, in a mass of wriggling little worms, disporting themselves in the smallest drop of fluid derived from his natural juices. The doom of Herod—"and he was eaten of worms"—to him needs no more elucidating commentary, and if the conscience-smitten patient does not, like the tetrarch, presently give up the ghost, he is in a very apt mood to part with all the cash he may have about him, in order to be kept out of a situation, the horrible nature of which, had it not thus been demonstrated to his senses, he could never have conceived. I have sketched no overdrawn picture, but rather one, I fear, of daily occurrence; and the manner all this is effected is exceedingly simple. The smallest particle of *sour paste*, previously placed on a slip of glass, lies imperceptible to the unpractised

never meant to infer that the vinegar itself contains no organic matter. But there is no need to discuss the question of heterogenesis with reference to vinegar; for *boiled distilled water alone* will, if exposed for a few days (under certain conditions of the atmosphere), be found to contain distinct types of *Infusoria*. This fact we discovered last summer, and communicated to Section D of the British Association. So our scientific readers must not suppose that we have been seeking to adduce evidence in favour of the theory of spontaneous generation.—ED.

eye, until a single drop of any fluid secretion from the body supplies the required conditions of moisture; and, accordingly, the little paste-eels are immediately aroused to life and activity, reversing the fable of the frogs and boys, as the lively enjoyment they exhibit is apt to prove a very serious matter to the human being so shamefully victimized.

EXPLANATION OF PLATE X.

Figs. 1 & 2. Young animals soon after leaving the egg.

Fig. 3. Male, full grown.

Fig. 4. Male, with reproductive organs *in situ*, separated at *c* and *d*, and magnified × 350.

Figs. 5 & 6. Females, with ovisacs *in situ*, containing eggs in various stages of development.

a a. Eggs thrown off and found floating in the fluid.

Fig. 7. A dead male, in which state they float about for days, until destroyed by vibriones.

THE EYE OF THE OX.

BY E. BECKIT TRUMAN.

HOMER, the sublimest, because the most natural, of the classic poets, expresses his idea of the majesty and beauty of the countenance of Juno, by the epithet *boōpis*, ox-eyed. The simile may, perhaps, appear a very humble one; but, by a little study of the formation of the bullock's eye, we may see that not only is the object worthy of the Homeric application, but that it contains numberless beauties of which the ancient Grecian never dreamed, disclosed to us by the aid of the dissecting-knife and the microscope.

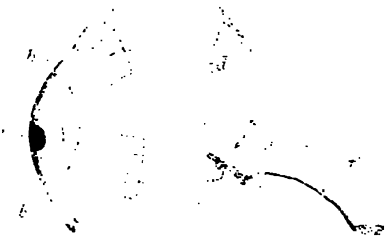
The delicacy of the internal organization of the eye requires it to have an abode where it will be protected from external violence. Such a dwelling-place we find in the orbit or socket of the eye: which is formed of bone on all sides, and lined by a cushion of fat, in which the eyeball is embedded; so that in the event of a blow being received on the only attainable aspect, the front of the eye, its force is transmitted to, and broken by, this soft layer of fat, and thereby prevented from rebounding injuriously on the eye from the unyielding wall surrounding it.

Having removed the eyeball from its socket, and divested it of the fat and the muscles, let us examine the contour of the eye (Plate XI., fig. 1). We see it to consist of two portions, of differing curvatures, the part in front (*a*) having the greater convexity; the remaining and greater portion having the form of a somewhat-flattened globe. The projecting body (*f*) is the optic nerve, the nerve that conveys the visual impressions to the brain; at *c* and *d* are the attachments of muscles cut short; and at *e* some blood-vessels are seen.

We will now examine, one by one, the different structures of which the eyeball is composed; and which consist (1) of tunics or protective coverings, (2) of a series of refracting bodies to bring the rays of light to a focus internally, and (3) a nerve to receive the impression of light (with certain auxiliaries).

The outermost covering of the eye consists of two very dissimilar parts; namely, the cornea and the sclerotic. The cornea, 4.

1.



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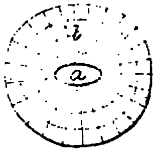

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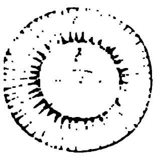

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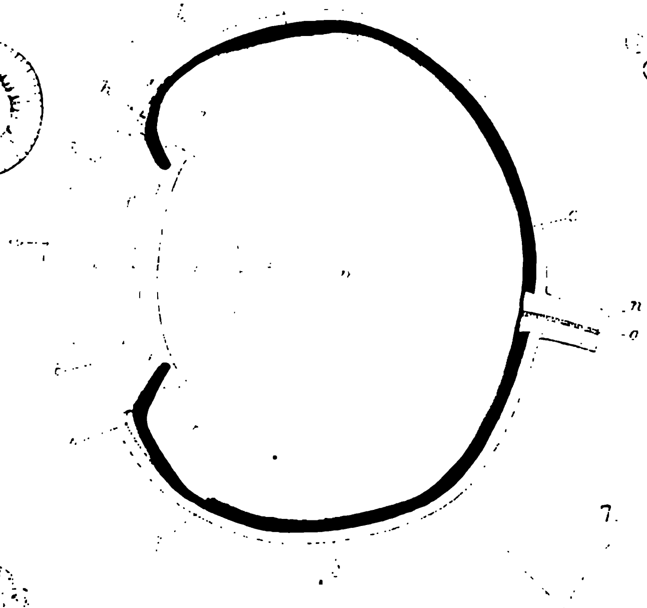

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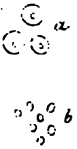

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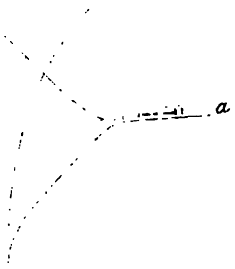

2.

W. West lith.

The Eye of the Ox
and its microscopical Structure.

so named from its similarity to horn (*corneus*, horny), is compared in shape to a watch-glass; it is perfectly transparent (in Plate XI., figs. 1 and 3, extending from *b* to *b*). Although perfectly transparent, even as glass (that is, to the naked eye), it has a fibrous structure (fig. 10), the fibres being very even and regular, and running parallel to each other; between the fibres are a number of tubes, pursuing also a regular, parallel course. In front of the cornea is a thin elastic layer, covered by a transparent cuticle; and behind the cornea is another elastic layer, which passes on and terminates in the iris. These elastic membranes preserve the proper convexity of the cornea (in fig. 3 the situation of these laminæ may be seen; in fig. 11, their structure is shown).

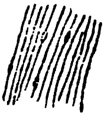

Fig. 10.

The sclerotic (*sklēros*, hard) is an exceedingly strong structure directly continuous with the cornea, and investing the eyeball completely, except where the cornea comes in (extending from *b* round by *c, c, c,* to *b* again, in Plate XI., fig. 3). It is about $\frac{1}{16}$ of an inch in thickness, and its fibres (Plate XI., fig. 4) are not, as those of the cornea, parallel, but run in contrary directions, mostly crossing each other at right angles; hence the dense and strong nature of this covering. What is popularly known as the white of the eye, is a part of the sclerotic, covered by a thin mucous membrane. To the sclerotic are attached the various muscles that move the eyeball, and behind, it is perforated for the passage of the optic nerve (Plate XI., fig. 3, *n*).

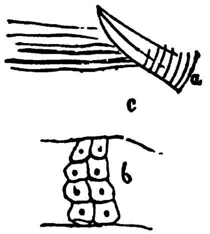

Fig. 11.

Looking at Plate XI., fig. 3, it will be observed that at *h* is a part coloured yellow: this consists of two structures, one behind the other; the first is called the ciliary ligament, the second, the ciliary muscle. By means of the ciliary ligament (a ligament being something that binds and connects parts together: *ligo,* to tie or bind), the iris (Plate XI., fig. 3, *f, f*) is attached to, and suspended from, the sclerotic. On removing the cornea and sclerotic, during which we must separate the latter from the ciliary ligament, we obtain a body similar to Plate XI., fig. 2. We notice that the eye has lost its high-arched form : this is due to the fact that the semi-fluid material forming the bulk of the eye has now but very weak structures surrounding it, and therefore tends to flatten downwards.

The choroid coat of the eye (like the chorion, which is a vascular membrane of peculiar formation, *chorion, eidos*), is that next beneath the sclerotic; it extends from the entrance of the optic nerve, which perforates it, to the ciliary ligament (Plate XI., fig. 2, *c, e, c*), where it forms the iris and ciliary processes. The choroid consists almost entirely of blood-vessels, and colouring matter, or pigment, contained in irregularly-shaped cells in the interval between the blood-vessels. By washing gently with water, the pigment on the surface may be removed, and we then see the veins running in great numbers, and in a beautifully-arranged manner, from behind forwards. The irregularly parallel lines seen in Plate XI., fig. 2, are the veins. The innermost layer of the choroid consists of a series of little bodies, called epithelial cells, arranged in the manner of a pavement; in the eye of man, and in the front of the eye of the ox, these are full of dark colouring matter (Plate XI., fig. 5, *a*). The back of the eye of the ox, however, instead of presenting a dull black appearance (as in man), is of a mingled blue and green colour, and very brilliant, having quite a metallic lustre. This is due to the presence of certain fibrous elements in the choroid, so arranged as to give the play of colours named: for there is, on examination, no colouring matter to be seen; the epithelial cells of this part having the microscopical appearance of *b*, Plate XI., fig. 5. This bright and coloured surface is of considerable extent, and is called the tapetum (*tapēte*, a carpet).

At *c*, Plate XI., fig. 2, is the ciliary ligament and muscle. At this point the choroid bends inwards to form the ciliary processes and iris. The ciliary processes (*cilium*, an eyelid or eyelash), (Plate XI., fig. 3, *g, g*, and the outer circle in Plate XI., fig. 9, where they are seen from behind), consist microscopically of the same structures as the choroid; they are formed by the choroid bending inwards and backwards from the ciliary ligament towards the lens (Plate XI., fig. 3, *i*); together they constitute a circular band, with a large central aperture at its circumference continuous with the choroid, and also attached to the iris, but free at its margin and front surface. These processes consist of folds or plaits which are arranged around the lens, "like the many petals of a flower;" the folds are both long and short: the long ones, about sixty in number, running concentrically along the entire breadth of the processes; the short ones are placed alternately with the long ones, commencing at the circumference, but terminating about halfway from the margin of the large central aperture.

The consideration of the iris and ciliary muscle we will reserve for the present, and will examine the layer immediately beneath the choroid, namely, the retina (*rete*, a net) (fig. 3, the scarlet line running around the globe). This is the nervous structure which receives the impression of light, and is formed by an expansion of the optic nerve (Plate XI., fig. 3, *n*), commencing at the entrance of the optic nerve into the eyeball, and extending as far as *l*, where it terminates by a finely-jagged border. The retina is an exceedingly delicate structure, and is admirably supported, as if on a water-bed, by a globular mass of almost fluid consistence. It is itself semi-transparent, and of a greyish-white colour; and is traversed by many branches of a blood-vessel (whence its derivation from *rete*), which is seen at *o*, in Plate XI., fig. 3, passing through the midst of the optic nerve to supply the retina with blood. The retina consists of two layers: Jacob's membrane, and the retina proper; Jacob's membrane (so named, because first described by Dr. Jacob) is the outer one of the two, and is seen as a thin film, by a careful dissection made in water: it is formed of a number of rod or club-shaped particles, lying side by side, and with the long axis vertical, the broad end of the particles being in contact with the choroid; the other end, of course, in opposition with the retina proper. The appearance of the membrane seen from without is represented in fig. 12, *b*; that of its vertical section in fig. 13, *a*; and that of the particles when detached at fig. 12, *a*.

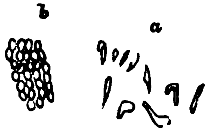

FIG. 12.

The retina proper may be described, in a general way, as made up of three parts: a fibrous, a vesicular, and a granular layer (fig. 13, *b*, *c*, *d*). The fibrous layer, *d*, is derived from the optic nerve; the fibres of which radiate from the end of the nerve, where it perforates the sclerotic and choroid, and forms a thin sheet of membrane: the vesicular layer, *c*, is composed of a number of delicate bodies called vesicles (*vesicula*, a little bladder or blister), seen separately in Plate XI., fig. 6, *a*. In the fibrous and vesicular layers the blood-vessels of the retina are distributed. The granular layer, *b*, is that which lies immediately beneath Jacob's membrane, *a*, and consists of particles, such as those in Plate XI., fig. 6, *b*.

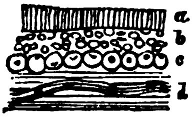

FIG. 13.

I have said that the retina is supported and kept extended on a semi-fluid material; this is called the vitreous humour (*vitrum*, glass), and occupies the whole of the space marked *m* in Plate XI., fig. 3. It is of the consistence of soft jelly, and is formed of an exceedingly fine and delicate web of fibrous tissue, which is at the same time transparent, and which contains within its meshes a watery fluid. It is bounded, at its circumference, where it comes in contact with the retina, by a thin and transparent membrane (the line next to the scarlet retina, Plate XI., fig. 3), called the hyaloid membrane (*hyalos*, crystal); when this membrane reaches the ciliary processes of the choroid (at *h*, fig. 3), it forms a number of plaits, similar in number, disposition, and size to those of the ciliary processes, and which are received into the folds of those processes. This plaited part of the hyaloid is called the *zonula ciliaris* (*zonula*, a little girdle). If, in Plate XI., fig. 3, we trace the hyaloid membrane to its termination, we see that it ends on the front surface of the lens, *i*, and immediately behind it, at this point, is a space, *k*, called the canal of Petit: this little cavity has an important function, and is bounded behind by the vitreous body, in front by the hyaloid membrane, and internally by the lens.

The crystalline lens (Plate XI., fig. 3, *i*, and fig. 14) is when seen from the front circular, when from the side doubly convex, in form; the posterior curve being the more convex of the two. The lens is surrounded by a membrane or capsule, that invests it completely; the capsule is of the same structure as the elastic lamina of the cornea. The front part of the capsule is three or four times thicker than the part behind; which latter part is adherent to the tissue of the vitreous body, and therefore is better supported than the capsule in front, which is in contact with a thin fluid, presently to be noticed.

The lens itself is of considerable consistence, such as the white of an egg when gently boiled; its density in the centre being greater than that of the outer part. Looking at it in front, we see, when the lens is beginning to lose its transparency, three lines, which commence at the centre and radiate outwards, dividing the lens into three equal parts; the same is observable on the posterior surface, but the lines behind are placed intermediately with respect to those in front. By hardening it in spirit we may separate the surfaces of the lens into three parts, and we then see that it is composed of layers or lamellæ (fig. 15); and these again consist of fibres, which, in the ox, have finely-jagged edges (fig. 16).* Notwithstanding all this complicated structure, the lens is perfectly transparent.

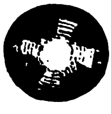
FIG. 14.

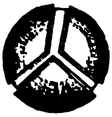
FIG. 15.

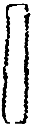
FIG. 16.

The parts remaining to be noticed are the anterior and posterior chambers of the aqueous humour, the iris and the ciliary muscles.

The anterior chamber (*d*, Plate XI., fig. 3) is bounded, in front, by the posterior surface of the cornea, and a small portion of the sclerotic; behind, by the front of the iris; *e* being the pupil of the eye through which the two chambers communicate. The posterior chamber is formed by the posterior surface of the iris, by the front of the ciliary processes, and lens, and a small part of the hyaloid membrane. These chambers contain a fluid nearly as thin as water; and therefore called aqueous humour (*aqua*, water).

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* From Todd & Bowman.

The iris (Plate XI., fig. 2, *b*, 3, *f*, 8, 9, *b*,) is a circular diaphragm, with a central aperture called the pupil (fig. 3, *e*, 8, 9, *a*); it is attached, at its circumference, by means of the ciliary ligament (which is seen with the ciliary muscle at *c*, *c*, Plate XI., fig. 2) to the sclerotic. The iris consists of muscular fibre, of blood-vessels, and of colouring matter. The direction of the muscular fibres is mostly radiating; but at the inner margin of the iris are a few fibres which have a circular arrangement around the pupil. The vessels are numerous, but slender and delicate. The colouring matter is situated in irregularly-shaped cells, which very much obscure the microscopic structure of the iris. When we speak of a blue eye or a hazel eye, we always refer to the colour of the iris; which is so named from its varying colours in different individuals (*iris*, a rainbow). The pupil is so named from *pupilla*, a young girl or child, as in the situation of the pupil, a diminutive image of the person looking at it is formed by reflection from the crystalline lens: amongst the Greeks, in the same way, the pupil was called *korē*, the daughter of the eye.

The ciliary muscle (Plate XI., fig. 2, *c*, 3, *h*) is a circular band, attached on one side to the sclerotic, and by the other to the front of the ciliary processes. Its fibres radiate from the attachment to the sclerotic, some to the posterior part of the ciliary processes, some to the more prominent parts, where the processes approach the lens.

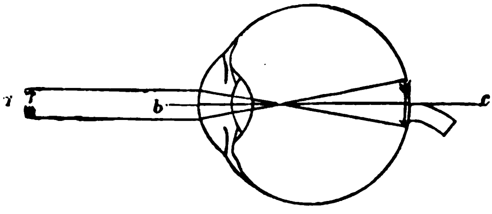

FIG. 17.

We will now consider the functions of the different parts of the eye during the passage of the light rays. We see an object, because rays of light are reflected from the surface of the object, and meet the eye, the impression subsequently passing to the brain. These reflected rays diverge from each other, more or less, according as the object seen is at a less or greater distance from the eye. At a distance of eighteen feet, however, the rays of light are already so little divergent, that they are accounted parallel; whilst at a less distance than eighteen feet the rays are called divergent. The course of parallel rays is as follows (fig. 17): reflected from *a*, the rays pass to and through the cornea, where they are bent or reflected towards the axis of the eye (*b*, *c*); they then pass through the aqueous humour to the crystalline lens, where they are still more refracted, so as to cross the axis of the eye, and, traversing the vitreous body, terminate on the retina, where an inverted image of the object is formed.

If any divergent rays from a near object were to pass through the eye, whilst the eye was in the same state as that in which the parallel or distant rays come to a focus, the effect would be that the picture of the object would form behind the retina, and thus perfect and well-defined sight would be impossible for near objects. To meet this there is a little mechanical arrangement in the interior of the eye. The ciliary muscle (Plate XI., fig. 3, *h*), attached in front to the sclerotic, and behind to the ciliary processes, when in action (that is, when the eye is adjusted for near objects), pulls forward the ciliary processes, and therefore the plaitings of the hyaloid membrane; and by means of the attachment of the hyaloid to the circumference of the lens, this body is also brought forward; the canal of Petit prevents the muscle acting on the vitreous body, by leaving a space between. By this means a greater distance is produced between the lens and the retina, and thus the image of the object is brought to a focus directly upon the retina.

There is nothing that man can construct to equal, in beauty of mechanism, the iris. It is a curtain, circular in shape, and with an aperture in the middle, which can either contract or dilate without showing the least puckering or plaiting of the surface of the iris. The contraction of the pupil takes place in a strong light, and is intended to exclude an excess that would act injuriously on the retina; the dilatation takes place in dull light or darkness, for the purpose of allowing every possible ray to pass.

During adjustment of the eye for a near object, it is turned inwards, and the same nerve by which this movement is effected causes contraction of the pupil. This contraction probably merely excludes excess of light, and does not aid adjustment of the eye; as adjustment has been observed to be perfect even when the iris was entirely absent.*

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* For much interesting and valuable information respecting the eye, see the second volume of Todd & Bowman's "Physiological Anatomy;" Griffiths & Henfrey's "Micrographical Dictionary" (Van Voorst), article ye"), and the books of reference there named.

EXPLANATION OF PLATE XI. AND WOODCUTS.

Fig. 1. The eye of the ox, seen laterally, the muscles having been removed. *a*, the pupil of the eye ; *b* to *b*, the cornea ; *c*, *c*, and *d*, ends of muscles ; *e*, blood-vessels entering the eye : *c*, *d*, and *e*, are on the sclerotic ; *f*, the optic nerve.

Fig. 2. The same ; the cornea and sclerotic have been removed. *a*, the crystalline lens, seen through the pupil ; the band, *c* to *c*, is the ciliary ligament and muscle ; *b*, the iris ; *e*, the choroid, showing its vessels ; *f*, the optic nerve.

Fig. 3. A diagrammatic section of the eye, enlarged. *a*, the cornea, consisting of anterior elastic lamina, cornea proper, and posterior elastic lamina ; *b* to *b*, by *a*, shows extent of cornea ; *c*, *c*, *c*, the sclerotic ; *d*, the anterior chamber of the eye ; *e*, the pupil ; *f*, *f*, the iris ; *g*, *g*, the ciliary processes ; *h*, *h*, ciliary ligament and muscle ; *i*, the crystalline lens, surrounded by its capsule, *j* ; *k*, *k*, the canal of Petit ; *l* shows the termination of the retina (the scarlet line) ; the black line between the retina and the sclerotic is the choroid ; the light line beyond the retina is the hyaloid membrane, which passes on to the lens ; *m*, the vitreous body ; *n*, the optic nerve ; *o*, the central artery of the retina.

Fig. 4. Fibres of the sclerotica.

Fig. 5. Epithelium of the choroid. *a*, from the dark part in front ; *b*, over the tapetum.

Fig. 6. *a*, detached vesicles ; *b*, detached granules, from the retina.

Fig. 7. Fibrous layer of retina ; *a*, a blood-vessel.

Fig. 8. The iris, seen in front ; *a*, the pupil ; *b*, the iris.

Fig. 9. The iris and ciliary processes, seen from behind ; *a*, the pupil ; *b*, the iris, partly hidden by *c*, the ciliary processes.

Fig. 10. Transverse section of the cornea proper.

Fig. 11. Section of anterior elastic lamina. *a*, cornea proper ; *b*, epithelium ; *c*, elastic lamina.

Fig. 12. Jacob's membrane. *b*, when seen from above ; *a*, appearance of detached particles.

Fig. 13. Section of retina. *a*, Jacob's membrane ; *b*, granular ; *c*, vesicular ; *d*, fibrous layer : along the latter is seen passing a blood-vessel.

Fig. 14. The crystalline lens, seen in front.

Fig. 15. The lens, separating into three divisions, and showing its laminated structure.

Fig. 16. Fibre of the crystalline lens (Todd and Bowman).

Fig. 17. Diagram to show the inverted image produced on the retina ; *b*, *c*, the optic axis.

Figs. 4, 5, 6, 7, 10, 11, 12, and 13 are reduced from the microscopic appearances at 250 diameters, drawn by the camera lucida.

MARS.

BY JAMES BREEN, F.R.A.S.

OF all the planets of the system, MARS, which for the last few months has been shining so brightly in the heavens, is that whose topographical details are best known to us. By glancing over the accompanying pictures of its telescopic aspect, we immediately perceive how much is revealed of its surface,—of its islands, continents, seas, and snows, by means of powerful optical aid. It is the planet which most strongly resembles the Earth in the duration of its days and seasons; the existence of an atmosphere is everywhere apparent: being proved by the dimness of the dark streaks and spots at the circumference, as compared with their distinctness at the centre of the planet (for at the former the solar light has to penetrate through a dense stratum of air, and is again refracted through the same thick medium);—by occasional clouds passing over its surface;—by the snow-zones piled up and stretching over vast spaces at its poles in the winter, which melt away gradually as the Sun ascends above the horizon in the summer, and dissipates the frost and darkness which for months previously had reigned in those arctic and antarctic regions. In the planet Jupiter a small telescope may more readily show the dark belts and spots; but those are ever changing and drifting about with variable velocity; the *terra firma* is scarcely perceived on this immense body, which appears to have an economy of its own, hidden from us by great masses of cloud, through an occasional break of which we perhaps sometimes catch a glimpse of the dark body of the planet. On the surface of Mars, on the contrary, the dark spots preserve the same position and relative dimensions, and we appear to be looking at a miniature globe pencilled over with dim seas and continents. From year to year the sea does not appear to encroach upon the land, nor the land upon the ocean; all the changes which are perceived are purely meteorological—the presence of clouds and murky weather, and snow during the winter,—of a clear atmosphere and sunny clime throughout the summer.

first circumstance we detect in looking at the planet its exceedingly red light, which is quite different from that of the other bodies that circulate about the Sun. This does not appear so prominently, however, when looked at with a telescope, as when seen by unaided vision. Still, however, even with the former, the orange light is very decided, and if compared with the Moon or a neighbouring white star, the contrast is sufficiently striking. Viewed when the whole disc of the planet is illuminated, its form appears quite circular, and no suspicion is aroused of a flattening at the poles, or bulging forth of the equatorial regions. But when the micrometer is applied, and careful measurements are made of its polar and equatorial diameters, several observers have agreed that there is a slight variation from the circular form, although the results which they have obtained are very discordant. Herschel was the first who suspected the elliptical form of the planet, and who patiently set about to determine the amount of this variation. To arrive at a knowledge of the figure of the Earth requires long and arduous labour; but in the case of the planets the method is more simple, and the diameters at different parts of the disc may be said to be measured with the same facility as if it were a palpable object. Herschel found that the proportions of the equatorial diameters of Mars were as 1355 to 1272, or near as 16 to 15. Schroeter could not perceive any such ellipticity, and was of opinion that the two diameters were in the proportion of 81 to 80. Arago found them to vary in the proportion of 31 to 30. The Greenwich observations of late years give this variation as 52 to 51, and as 62 to 61. Other observers, among whom is Bessel, have not been able to detect the slightest difference between the diameters. Herschel, however, states, that on one occasion he showed the planet to some scientific friends, one of whom considered that it was as considerably bulged out at the equator as the globe of Jupiter. At certain times, as the whole surface of Mars is not illuminated, it will appear of the same figure as the Moon when three or four days before or after full; but even when this was the case, the flattening at the poles was still readily perceived by Herschel. There are a few circumstances which militate against the correctness of those measures; sometimes the white cap of snow seems to project over the edge of the planet, at others the equatorial margins are exceedingly bright and radiating. According to theory, the proportion of the polar to the equatorial zone should be as 192 to 193; but different degrees of density at various parts of the globe would, of course, alter this. By observations made in September and October of 1862, Mr. Main concludes its polar diameter to be 4,221 miles, and its equatorial 4,332 miles,—a great difference for a small body like Mars, which has almost the same density as the Earth. In the latter body, the difference between the polar and equatorial diameters amounts only to twenty-six miles; these quantities being respectively 7,899 and 7,905 miles.

Be the planet circular or elliptical in figure, however, it is easy to see that it rotates on its axis, and that too in about the same time as Mercury, Venus, and the Earth. In other respects, also, the similarity is striking, these planets being nearly of the same size, globular figure and density, and differing greatly from the huge exterior planets in those respects. The rotation of Mars is readily perceived by watching it from hour to hour throughout the evening, when it will be seen that the dark spots pass over the disc from west to east in the same sense in which the Earth is rotating. In about twenty-four hours and thirty-seven minutes, or on the following evening, the spot which was first observed will be found to have returned exactly to the same position, and the others will follow in the same succession as on the previous day, the polar snow-spot retaining nearly the same place. By further watching, the patient observer will find that the equator of Mars is only inclined a few degrees more to the plane of its orbit than that of the Earth, and that, consequently, their seasons are about the same. From the longer year of Mars, however, the interval during which the polar regions are hidden from and exposed to the rays of the Sun, is very different. At the latitude of the British islands, the shortest day on Mars is only about six hours, whilst on the Earth it is between seven and eight. The longest day on Mars, at the same latitude, would be nineteen hours, whilst on the Earth it is only seventeen hours. At seventy degrees of north latitude the Sun remains above the horizon for sixty-nine days, whilst on Mars at the same latitude it is above the horizon for 169 days. The pole of Mars is exposed to the Sun for 338 days, and hidden from it for the same time; whilst on the Earth the polar day or night is only 180 days.

Some observers have complained of the striking monotony and uniformity of the surface of Mars. If we cast a glance at the accompanying pictures of the planet, we shall hardly be disposed to indorse this opinion. On the contrary, the variety of scenery is deeply interesting. The seas, or dark portions, are remarkably sinuous in their course; the indentation of the coast, caused by bays and creeks, is very picturesque. It is true that mountains and vales, such as those on the arid surface of the Moon, cannot be perceived; but by attentive watching, it will be seen that the bright portion of the planet is curiously dotted over with a mottled ground, and that the dark seas vary greatly in the intensity of their tint, even when the spot is at the centre of the planet, and is viewed most favourably. It would appear, from a cursory view, as though the surface of Mars were pretty equally divided between land and water, the former, indeed, from Maedler's map, having somewhat the predominance, whilst on the Earth the ocean covers three times as much space as the land.

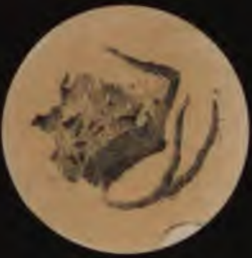
Whilst observing the spots on Mars, we are somewhat astonished to see that, as they pass from the centre towards the margins of the planet, they become rapidly fainter, and that at the edges they are entirely obliterated. Even the darkest spots on Mars (those which are seen between twenty and forty degrees of south latitude) undergo this change as they approach the margins of the planet. Occasionally the whole circumference of the planet is surrounded, as it were, with a luminous ring, as in Plate XII., fig. 1, which represents the planet as seen by the writer in the 20-foot refractor at the Cambridge Observatory, in the opposition of 1856. This is generally held to be due to its atmosphere, which is considerably thicker at the edges than at the centre, just as during a fog we can perceive the blue sky and stars over-head, which are quite invisible at the horizon, where the atmosphere is considerably deeper and thicker. We might thus conclude that Mars has an atmosphere of considerable density; and this is confirmed by other circumstances. The older observers attempted to prove the existence of a dense atmosphere in Mars, by the disappearance of stars even at considerable distances from the planet, which they imagined had been eclipsed by its extensive gaseous envelope. This has been repeatedly tested in modern times, and with the best instruments, but without success. The elder Herschel followed very faint stars close up to the margin of the planet, and Sir J. South has repeated the experiment more recently without perceiving any change in the brilliancy or colour of the very small stars selected. Whilst Cassini could not perceive a star of the fifth magnitude within six minutes of the margin of the planet (on Oct. 1, 1672), Herschel could perceive stars of the twelfth and thirteenth magnitudes within three minutes of its disc. Herschel, however, fully believed in the existence of a dense atmosphere surrounding the planet,

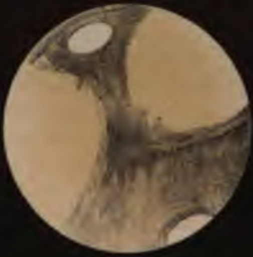
having often seen, besides the permanent spots on its surface, occasional changes of partial bright belts. The late Dr. Pearson saw a similar phenomenon in 1828, having noticed a dark cloudy spot to have changed its position, in an interval of four days, from the side to the top of the planet (see diagram). One very persevering observer, however (Maedler), thinks that many very natural mistakes may occur on this point, and considers that if the spots are not narrowly scrutinized each night, one of them may readily be mistaken for a cloud. This observer has, however, noticed that the spots on Mars are of varying colours at different times; some of them are black, others yellowish-red, and others again of a greenish tint. On the Earth, however, the same change of tint would be apparent: the great forests would be dark in comparison with the bright sandy deserts; the Black, White, and Red seas might appear of different tints; yellow fogs and the "brickdusters" of Australia would cause a proportionate change in the apparent colour of the countries which they enveloped, and over which they hung. This is perhaps a more natural explanation of the colour of Mars than that which accounts for its peculiar appearance by the tints assumed by the vegetation on the planet. Without, however, having recourse to accidental fogs and clouds, it has been supposed that the dense atmosphere of the planet absorbs all the violet rays of the solar light (which has to pass twice through its atmosphere before reaching the Earth), and that only the red rays—those of the rising and setting Sun when passing through dense mist or cloud—make their way to our planet, the others being either reflected or absorbed.

Let us now turn our attention to the snowy zones about the north and south poles of the planet. By direct measurement with an instrument for estimating light, it has been found that those white spots have twice the intensity of the dun-coloured portions of the planet. In the earliest years of telescopic discovery they were duly noticed, and their appearance and disappearance, and the various changes which they underwent, were curiously scrutinized for a considerable length of time, before, however, any one surmised that the changes were caused by atmospheric variations. By his observations between 1779 and 1784, the elder Herschel placed this matter beyond all doubt. In the latter year he detected all the changes which have since been observed and confirmed in this planet; and although Maraldi had seen the changes, and prophesied the extinction of the north snow-spot as far back as 1719, yet to Herschel is due the credit of their complete examination. He was the first to show that the snow was not exactly placed at the poles of the planet. This is very apparent from our 3rd, 4th, and 5th figures, which have been very carefully drawn by Secchi; the first in 1856, and the two latter in 1858, with fine *optical* and atmospheric circumstances in his favour, and which,

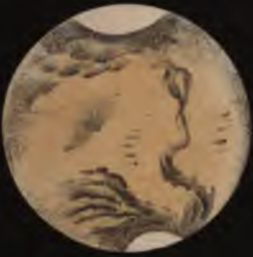
Plate X

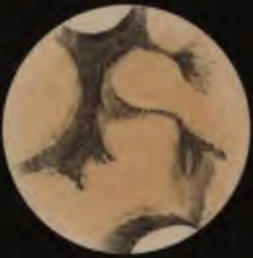
Fig 1



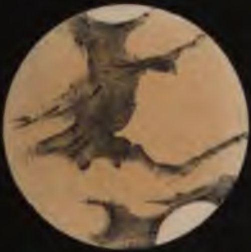


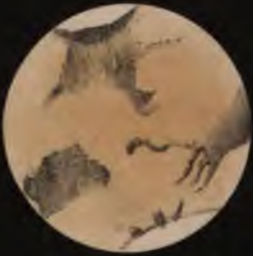
ig 3



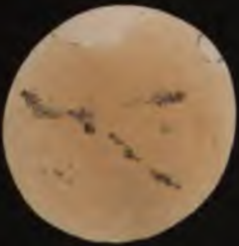


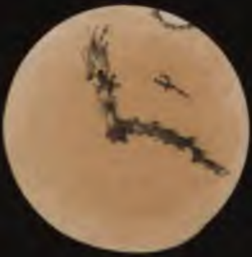
ig 5





g 7





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in addition, show the seas and continents of the planet to great advantage. In those three instances the snow-zones were touching the margins of the planets, but in the second figure (taken by the writer on April 23, 1856, with the great Cambridge Equatorial) the south, or uppermost pole, was quite isolated. As a proof of the brightness of the snow-spots, it may be mentioned, that on this occasion, when a cloud passed over and completely obliterated the planet, the snow-zones were quite large and bright, and appeared like faint stars struggling through the mist.

Let us follow those spots through their regular changes. The planet comes into view on the Earth; the northern part, after a winter season about as long as one of our years, again receives the beams of the Sun. The patch of snow, as it appears to us, at first large, diminishes gradually, and finally vanishes. After having had the companionship of the stars and of the night for a great interval, and passed a long period under the dominion of darkness, the Sun appears, and to the protracted night succeeds the equally long day, with its fierce heat and light. Nothing occurs between the fiery summer and the bleak and dark winter; the other two seasons are wanting, but the one which is present amply makes amends for those which are absent, by the intense changes which take place in a comparatively short time. The Arctic seas, which were previously blocked up with solid ice or frozen snow, and have stopped the passage by sea and land, are gradually thawing; the Northern again becomes liquid, the snows melt, the ice passes into its primeval condition, the land becomes passable, and the Sun—the cause of all this commotion—keeps in sight all day long, as if to tyrannize over those whom it has previously, by its absence, subjugated. The air becomes clearer, fogs have disappeared, the seas and continents have apparently a clear atmosphere overhead,—if we are to judge by the facility with which we view them, the November mists and murky atmospheres have been succeeded by a dry air and sunny skies. The opposite changes take place in the southern hemisphere, whilst these variations are progressing in the northern. In the former, however, the extremes of heat and cold will be more severely felt. From the great eccentricity of Mars, the distance of the planet may vary between 131 and 158 millions of miles from the Sun; but when it is summer in the southern hemisphere, the Sun is nearest the planet; when winter, it is farthest from it. The quantity of heat and light received at those times by the southern portion of the planet are respectively 0·52 and 0·36; that of the Earth being 1·00. The consequence is, that the summers are hotter and the winters colder on the southern than on the northern hemisphere. This is confirmed by observation; for whilst the northern patch of snow varies but slightly in dimensions, the southern is of great size in the winter, and almost vanishes in summer.

From the foregoing facts, and the deductions which may naturally be drawn from them, the reader has ample means for judging, in this individual instance at least, as to the probability of the planets being the abode of animal and vegetable life. It would be impossible, of course, to give any minute details on this point,—to say that such a place is forest land, or cultivated ground, or artificial formations; for when Mars is nearest the Earth—making use of the most powerful telescope yet constructed,—the observer is merely able to tell whether a space of ground which is two hundred miles long by two hundred broad, or an area of 40,000 miles, is round or square. From this circumstance, the observations of Schroeter, who saw clouds passing over the planet with a velocity from forty to sixty times that of the most violent hurricanes on the Earth, have been much doubted. But otherwise we have every evidence of an atmosphere, of snow, of changeable weather, of bright and sunny skies, of the existence of water. The seasons, though not so equable in duration as those on the Earth, are still present, with all their agreeable changes; we see the seed-time and harvest, the ripening summer and the dark winter. The isothermal lines on the Earth are reproduced on Mars, if we are to judge by the position of the snow-zones, which are not placed exactly at the poles. Nor does the excessive cold which might be surmised to take place from the planet's distance from the solar heat really appear to be so severe. Whether, from some peculiarity in the atmosphere, the latent heat of the body itself, or other causes unknown to us, the polar snows do not appear of the vast extent which might be imagined. Even those thaw away with a rapidity which seems marvellous, whilst the equatorial regions are altogether free from such visitations. Venus receives four times the heat of Mars, and twice that of the Earth; yet at the North Pole of Venus, a bright white and large spot has been perceived, which may naturally be surmised to be of the same nature as the snow-capped poles of the Earth and Mars; and we might from this conclude that no great difference exists in those three planets at least, whatever may be the case in the other two groups of planets,—*i.e.*, the seventy-six asteroids, or the huge exterior planets of small density, quick rotation, and accompanied by numerous moons and a ring.

The diameter of Mars is about twice that of the Moon, and more than one-half of that of the Earth. Its surface is about four times greater than that of the former, and is one quarter that of the latter. Bulk for bulk, Mars is seven times larger *than the* Moon, and the Earth is seven times larger than Mars.

Weight for weight, the Earth is more than seven times heavier than Mars. It would take upwards of two and a half millions of bodies like Mars to counterpoise the weight of the Sun. We thus see that Mars, with its diameter of 4,100 miles, holds a geometrical mean between the Moon and the Earth. The attraction, fall ot bodies, and length of pendulum, are about one-half of what those are on the Earth. Unlike the latter body, it has no satellite, although, if this latter were thirty miles in diameter, it could not pass unnoticed.

Maedler has calculated the duration of the seasons in Mars, which are as follows :—

From Spring to Summer (Spring in North, Summer in South),	191	days.
„ Summer to Autumn (Summer in North, Winter in South),	181	„
„ Autumn to Winter (Harvest in North, Spring in South),	149	„
„ Winter to Spring (Winter in North, Summer in South),	147	„

It will thus be seen that there are 372 days of spring and summer in the northern, and only 296 days in the southern hemisphere. The winter in the north only lasts 147 days; in the south 181 days. The heat and light in the northern summer is as 20 to 29 to the south. The consequence of this will be, that there is a long temperate summer, and a short mild winter; whilst in the southern, there will be a short hot summer, and long and severe winter.

The sixth figure gives a map of one of the hemispheres of Mars, as drawn by Maedler, and shows what may be done by means of a small telescope. The seventh and eighth figures represent the opposite hemispheres of the planet as drawn by the writer on December 10, 9h. 20m., and November 22, 10½h. P.M., 1862. The spots in the seventh figure would appear to be the best defined of the planet, and bear a striking resemblance to those seen in 1719 by Maraldi, on August 19 and 20, and September 25 and 26, as also to that seen by Sir W. Herschel on October 10, 1783, at 6h. 55m. P.M.

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THE BRITISH ASSOCIATION AT CAMBRIDGE.

PART I.

BY PROFESSOR D. T. ANSTED, M.A., F.R.S.

THE late meeting of the British Association, held during the first week of October in the University of Cambridge, has been one of those that may be regarded as successful, both in reference to the scientific men present and the communications made. It was not large, numbering only about 1,200 members in all; but the absentees, though including some well-known and familiar names, were chiefly the amateurs of science, associates, ladies, and those who join only for the current meeting; not working members, to whose labours the meetings are chiefly indebted for their important practical results. The sections were fairly attended, without being crowded, except on some few special occasions. The evening meetings were also well attended; and although the monetary returns will hardly be very brilliant, the reminiscences of Manchester and the prospects of Newcastle will console the treasurer for the comparative emptiness of the purse on this occasion. The Association meets one year for itself and another for the place it visits. At Cambridge, on the occasion of this, its third visit, there was not much enthusiasm, but there was a very pleasant assemblage of numbers of old members, who had been long without seeing one another, but who were not less warm in their greeting than if they had been annual attendants and had kept up acquaintance by frequent visits to the annual reunion.

An absence of excitement and "sensation" certainly characterized the meeting. The President (Professor Willis), in his address, rather recalled attention to the early labours of the Association, and the fruits it had borne years ago, than to the present state of science.

The evening lectures were on subjects already worn somewhat threadbare by frequent repetition at the Royal Institution, and were certainly not complimentary to the Cambridge audience. It is much to be regretted that Mr. Glaisher's interesting account of his balloon ascents did not replace one of these, and that a notice of recent researches in some interesting department was not introduced in place of the other. In spite, however, of these mistakes, the meeting was pleasant and satisfactory, and the communications and discussions not unworthy of the occasion.

Of the different sections, that known as A—Mathematical and Physical Science—offers the greatest variety of subjects, and receives a number of communications that do not properly belong to it. Some of these should be considered in E (Geography and Ethnology), and others, perhaps, in B (Chemistry). It is no doubt difficult to determine in many cases in what way to limit so very general a term as Physics. Including Astronomy and Magnetism and, perhaps, Meteorology, it is apt to absorb Physical Geography. In something of the same way, B (Chemistry) and C (Geology) occasionally overlap. D (Natural History), if strictly confined to Biology, would be tolerably independent, though not unfrequently there are links connecting it very closely with Geology by the medium of Palæontology. Physiology is regarded as a branch of Natural History, and Statistics (F), of course, finds place everywhere. Mechanics (G) is tolerably well defined. Omitting any reference to Section D, which is in other hands, I propose to recall some of the principal and more interesting communications and discussions, not so much in a systematic outline as in a general statement.

Mr. Glaisher's balloon report, already alluded to, was the most attractive paper of the meeting, and certainly included all the elements of a popular lecture. As a meteorological communication, it was given to Section A. There were several other papers of interest, connected with meteorology, climate, and other departments of Physical Geography, about which we may say a word; some being communicated to Section A, and others to Section E. It is to be regretted that a better arrangement is not made with regard to such papers. At a scientific meeting, Physical Geography should certainly receive more consideration than Descriptive Geography and Travels, to which the geographical part of E has been mainly reduced, while Climatology—too important a branch of science to be neglected—ought not to be carried to general Physics, which is already too crowded with other matter more strictly belonging to it.

The balloon ascents of Mr. Glaisher are direct results of British Association work. It has long been felt, that to determine the condition of the upper part of the atmosphere, it was not sufficient to make observations on high mountains. In such cases we always carry the earth with us, and the mere existence of a mountain-chain is a serious cause of disturbance to the atmosphere. Even isolated conical peaks in detached oceanic islands are not satisfactory. On the other hand, the car of a balloon is not a very favourable station for observing; the work required to be done involves unusual accuracy and rapidity of observation, and the instruments used are very liable to injury in the descent. A large balloon, great precautions in managing it, and repeated experiments by practised observers, were indispensable; and these are not easily obtained. Moreover, the balloon is a costly instrument for experiment, and its use involves much danger to the inexperienced. The means, however, being furnished by an association grant of last year, an observer was found in Mr. Glaisher, than whom no man living is more fit for work of this kind.

It appears, also, that Mr. Coxwell has fully justified his reputation as the first living aërial engine-driver. He is at once intelligent, instructed, and experienced,—sufficiently bold, but by no means reckless.

The number of ascents recorded is eight, and the average time in the air in each case was under two hours. The extreme height reached was above 30,000 feet; but there are no means of telling how much higher the balloon rose, as in this ascent Mr. Glaisher was, unfortunately, insensible from cold and exhaustion, during the critical time, and Mr. Coxwell was little better. The season of all the ascents was autumn, the dates ranging between the 18th August and the 8th September. The rate of ascent and descent was various, but sometimes extremely rapid, amounting to several thousand feet in a few minutes. The number of observations required to be made almost at the same moment, during the whole ascent, is enormous, but they seem to have been made with certainty, and without inconvenience, except at extreme elevations.

The conclusions arrived at, though only partial, were interesting and important; but they require confirmation and comparison with those made at another period of the year. The observations will probably be repeated in the spring of next year, and the results will be looked forward to with great interest at the Newcastle meeting.

Mr. Glaisher's account is graphic in the extreme, and the effects he saw on some occasions, when the balloon rose above a mass of clouds into the clear blue vault of heaven, are described as altogether surpassing in grandeur and beauty any cloudscapes visible from *terra firma*. This part of his narrative has, however, been frequently quoted in the daily newspapers and weekly journals, and need not be repeated.

Among the scientific results obtained by these balloon ascents are the following:—1. There seems no wind blowing steadily with any uniformity of direction in the upper regions of the air over our island at any height yet reached. 2. The clouds do not seem to form according to the contour of the land, but do seem to follow the tide up the great rivers. 3. The temperature not only does not decrease regularly as greater height is attained, but, in some cases, a very low temperature was attained near the earth, and was succeeded by much warmer air at a far greater elevation. 4. The aneroid barometer may be used with advantage, and may be depended on to any attained height. Mr. Glaisher states that it is available to a pressure of only five inches of mercury. 5. The humidity of the air diminishes rapidly, and at a height of five miles is extremely small. Several suggestions were made by various members in reference to aërial navigation generally, and the whole subject was recognized as of the greatest importance.

Memoirs were communicated on Climatology and Meteorological Instruments by Mr. G. J. Symons, Mr. Plant, Professor Ansted, Dr. Gladstone, Mr. Galton, Mr. Lowe, and other members. Some of these were of much interest, but we have not space to allude further to them. Mr. Lowe's paper on Ozone was especially valuable, and included the description of a new Ozone box, showing some interesting results.

The structure of the sun's surface and the volcanoes of the moon were the subject of several communications. Mr. Nasmyth pointed out some recent observations tending to prove that the sun's nucleus is dark and dense;

the light emanating from an outer envelope of lenticular filaments, not distributed in symmetrical order. He estimated these filaments at about 1,000 miles long by 90 miles broad, and stated that they move among themselves with enormous velocity, separating to form spots, and filling in to obliterate them. They are regarded by Mr. Prichard as solid. Some admirable representations of lunar volcanoes were exhibited and described.

On the whole, not less than seventy-six communications were referred to Section A, this being more than one-fourth part of all memoirs received, and more than double the number read at any section but Geology. Of these, at least twenty were strictly meteorological, and belonged much more to Physical Geography than to General Physics. In Section E (Geography and Ethnology, including Archæology) there were in all only twenty-eight memoirs, and of these only four related in any way to Physical Geography, while seventeen were mere narratives of travel.

In Section B, the communications were not of popular interest, and were chiefly technical. There was, however, one paper, by Mr. Lawes and Dr. Gilbert, on the subject of Manures and their action on grass land, interesting to the agriculturist. Many of the geological communications and discussions were also technical; but, as usual, there was a sufficient sprinkling of popular matter to attract strangers and ladies. Perhaps the most interesting novelty was the notice of Dr. Falconer's pigmy-elephant bones, of which some were obtained, three years ago, from a cavern in Malta, by Captain Spratt, R.N., and retained quietly by Dr. Falconer till a sufficient number of specimens had been received to decide every point of structure. There was something unusually interesting in the result of this reticence. Instead of the usual announcement of a new species from a single tooth or fragment of a bone, Dr. Falconer, as soon as he obtained the first instalment of news regarding so curious a variety, simply put his specimens by, and urged his friend, Captain Spratt, to search for and send more. He sent more; but, still, other bones were wanted; and, at last, in this way, a series was got together which really left nothing to be desired. Then our cautious Doctor, who has made elephants his special study, found himself in a position to bring down to the Association a perfect *embarras de richesses* in reference to this new form. He has bones and teeth of individuals of all ages, and, comparing them with corresponding bones and teeth of the Indian or fossil species, he exhibits all the peculiarities of structure. This pigmy was, when full grown, about the size of the Malay tapir, but was in all respects a true elephant in structure, having tusks and teeth in all respects elephantine. It inhabited Southern Europe up to a comparatively late tertiary period.

The drift question and the deposits of loose and alluvial mud in the bed of the Rhine and other rivers,—the gravel, and its connection with the glacial period, and the facts of chief interest in reference to this question, were the subject of many papers and of some very interesting discussion. This department of Geology is now clearing itself, and, before very long, will afford the latest, and probably the most instructive, chapter in all geological works. It still remains surrounded with difficulties; but they will disappear one after another, and we shall then be able to connect the present with the past.

The subject of coal was introduced by Professor Ansted in two papers,—one referring to a newly-discovered tertiary coal, of excellent quality and strictly bituminous, found in Hungary; and the other pointing out the difference between coal with bituminous schists. Dr. Sterry Hunt also made a communication on the subject of the Rock Oils of North America. But little discussion followed, and the question as to the origin of coal was not gone into. The discussions generally in the geological section were somewhat tame. Mr. Sorby communicated a very interesting addition to his observations on the structure of shells, pointing out that certain parts of the animal and certain animals habitually deposit carbonate of lime in the shape of *aragonite*, while other animals, and some other parts, deposit *calcite*. The aragonite form is not, however, so permanent as that of calcite, and hence it is apt to disappear or pass into calcite during fossilization.

Section E did not present much that was new. Sir R. Alcock, on Japan; Sir C. Nicholson, on recent explorations in Australia; Captain Burton and Mr. Jules Gerard, on African discovery,—all promised well, but failed to keep up the interest their subject matter seemed to offer. There was, however, an interesting communication by Mr. J. Wright, on an archæological subject, started at the Oxford meeting, arising out of the excavations on the site of the ancient Roman city of Uriconium, on the borders of Wales. Numerous human remains were there discovered, and of some of these the skulls are strangely and systematically distorted. As all the regular interments within the walls consisted of bodies that had previously been burned, the persons whose skulls remain were probably destroyed when the city was sacked and burned. The skulls of the Roman inhabitants seem not to be injured, but buried in a spot supposed to be an entrance to the town, and under circumstances which seem to show that they are certainly not older than the Roman period, and probably not much newer. There were found eleven skulls, seven of which were singularly and uniformly deformed, having an unnatural twist, which causes one eye to advance beyond the other, and gives an obliquity to the face. The cause of this has not yet been determined.

Several communications of great interest were made in Section F (Economic Science and Statistics). Among the most important, both for subject and treatment, may be mentioned one by Mr. Vernon Harcourt, on scientific evidence, and two or three, by competent authorities, on the course of studies and the expenses of student life at the University. Valuable and lively discussions took place with reference to all these.

It has long been felt that the position of a man of science called on to give evidence in a court of law is difficult and unsatisfactory. He receives his instructions and information on the question at issue from one side, and as there are few subjects that do not admit of two opinions, he naturally and inevitably makes the best of the case put before him. To some extent, he thus becomes an advocate, and his real judgment is biassed. It was proposed by Mr. Harcourt that, in place of scientific evidence, as now received, skilled assessors should be appointed by the judge on application, and that they should give their opinion in writing. Mr. Whiteside, Q.C., while admitting the necessity of some change in the present system, perceived practical objections to the appointment of assessors. The matter was referred back for reconsideration.

The studies at the University, the distribution of University and College rewards, and the cost of University education, came also under consideration. It is undoubtedly the case that, up to the present time, the effect of the new measures recently introduced has been very small, so far as Cambridge is concerned. The Natural History sciences are, indeed, acknowledged, and examinations are held, at which those who have graduated may test their progress; but hitherto these are not the subjects for which scholarships and fellowships are granted. The general feeling in the University, and among University men, is not favourable to any fundamental and rapid change. It is fortunate that such is the case. The time has not come when Englishmen are to regard mere *cram* and the acquisition of facts, however important, as taking the place of cultivation of the intellect; and at present, at any rate, there is no department of science, not admitting of mathematical expression, that can be regarded as equivalent to the study of pure mathematics and grammar in preparing the intellect for the subsequent work of life, in the pulpit, at the bar, in medicine, or in the House of Commons.

The Mechanical Section (G) was attractive and the papers important. It would be difficult to present a more admirable and practical illustration of the value of pure mathematics to practical men than that offered by the Astronomer Royal in this section, when illustrating the nature and direction of the forces concerned in the case of a tubular latticed bridge with a train crossing it. By a masterly resolution of a very difficult problem in pure mathematics, he showed how a set of extremely simple formulæ were deduced, which led to direct practical conclusions identical with those obtained by series of experiments, numerous, costly, and dilatory, by which alone our great mechanicians had practically determined the ordinary rules-of-thumb. The parts of the bridge that might with advantage be left weak, those where unusual strength was needed, and the necessity of enormous strength in the piers supporting the two ends, were illustrated in a simple diagram. Mr. Fairbairn and Mr. Scott Russell, who represent all that is most intelligent and bold among mechanicians, explained to the meeting the curious processes by which each for himself had worked at the mathematical problem in vain, and had then, by a series of trials, obtained; by an exhaustive process, a result resembling that here given. It would not be possible to show a more interesting and instructive example of the application of high mathematics to resolve a difficult practical problem.

A memoir on Artificial Stones, by Professor Ansted, was the means of directing attention to a new material recently introduced by Mr. F. Ransome. This stone is so very easily and cheaply made, of any rough mineral matter that may be at hand, the process is so extremely rapid, and the resulting material is so uniform in its texture, moulds so admirably, and presents so smooth a face, that it is likely to supersede terra-cottas and cements. It is a curious instance of an important discovery arising out of experiments in another direction. Endeavouring to prove that he was able to preserve decaying stone, the inventor found himself manufacturing a substance that might well replace decaying stone. It is already being made on a large scale, some of the work of the stations of the Metropolitan Railway recently opened being constructed of it.

It may well be supposed that unsinkable ships, projectiles and guns, and iron plates, would not escape discussion. Much good sense was shown in discussion, but there did not seem any very new views, the general conclusion being that the gun, as at present used, can throw a projectile that shall penetrate any armour hitherto made.

Two excursions were made during the meeting. One, by the Geologists and Naturalists, to Hunstanton, in Norfolk, where there is an interesting cliff showing the bottom beds of the chalk, and the rocks coming out from beneath, and where some good fossils have been obtained. The other was by the Mechanical Section; the object being to see the works now nearly brought to a conclusion that are intended to remedy the evils caused by the recent destruction of the Middle Level sluice and the flooding of the Fens. A few hours after the party had left the Fens, another similar accident occurred, on a smaller scale than the first accident; but still one that it would have been interesting to witness in its early stages.

The work of the general committee at the meetings of the Association involves the confirming the suggestions and reports of the council and the committees of recommendations, and the selection of the place of the next ensuing meeting. The money grants made at Cambridge were somewhat large, amounting to nearly £2,000. Of this sum the Kew Observatory, as usual, absorbs the lion's share. There is, perhaps, no work undertaken by the Association that has borne better or more important fruit than that connected originally with Terrestrial Magnetism, and afterwards carried over all departments of Meteorology. When the Association was originated at York, in 1832, the science of Meteorology was barely recognized. It has grown and flourished under the auspices, and has always been an *enfant chéri*, of the governing body at each successive meeting. Terrestrial Magnetism and Meteorology are, indeed, the branches of modern science that owe most to the Association; and when we say that nearly £1,000 were appropriated, at Cambridge, to keep up the Kew establishment and assist in investigations in the department of physics, including balloon observations, it will be evident that there is no falling off in this direction. Other grants are by tens, but these by hundreds; and, so long as there are no other means available, it is fortunate for the reputation of British science that such is the case.

The position of the Association has greatly changed since the time when its meetings (then, at most, amounting to a few hundred members) were greeted with ridicule, and when its efforts were regarded as useless. It has long since fought its way to a position which enables it to command the attention of the Government when any important scientific object is to be attained, and by its Parliamentary Committee, and its Permanent Council, acting in concert with the Royal Society, it has already done much good. That the direct results have not been even greater, is not because its members have [illegible] is but a short time since the reasonable demands of scientific men for grants of public money to carry on investigations of pure science were first seriously listened to. They are now rarely refused, and this has arisen from the development of a combined action, mainly induced by the meetings of the Association and the bringing together of men from all parts of the country, earnestly and honestly pursuing similar investigations and discussing, with perfect freedom, the bearings of every question brought before them. A voice of this kind could not but be heard; and as the meetings have now been held, not only in each University, more than once, but in most large towns throughout the kingdom, and the members have always been received with open arms as public benefactors, their recommendations coming continually with more and more force.

We have endeavoured to show in these few remarks that the variety of subjects embraced at the meetings is as great as the spirit of the Association is catholic. The range is, indeed, widening rather than narrowing, and this in spite of the vigorous branches that have been thrown off from time to time. There is, beyond all doubt, a spirit of vitality and an amount of energy developed that show no symptoms of decay; and as the original members, now old, are being well replaced by younger men rising into distinction, it is to be hoped that the stage of doubtful and weakened activity that supervenes on all societies when the founders suddenly quit the field and their successors are hardly familiar with their work, is now well passed, and that a long and useful future may be anticipated.

PART II.

SECTION AND SUB-SECTION D.

ZOOLOGY, BOTANY, AND PHYSIOLOGY.

BY DR. COLLINGWOOD, F.L.S., &c.

At the opening of this Section on Thursday morning, October 2nd, the President, Professor Huxley, F.R.S., delivered an excellent address of one hour's duration, selecting for his subject, "The Condition and Prospects of Biological Science." Biology is the science which investigates the nature and relation of organized beings, and that comprehensive subject he divided into the following sub-groups. 1st, *Morphology*, or the doctrine of form and structure, including the almost new science of Development, for which we were chiefly indebted to the Germans; Anatomy and Histology, or the anatomy of the tissues; and Taxonomy, or the systematic classification of plants and animals. 2nd, *Physiology*, which takes cognizance of the vital functions, sustentative and generative, performed by organic beings. 3rd, *Distribution*, whether in time (Palæontology), or in space (geographical distribution). 4th, *Ætiology*, or the laws of origination and variation, including the physiology of direct and indirect conditions. These were the objects of the science, and taking up each, *seriatim*, he dwelt upon the progress they had respectively made in the last half-century,—a progress which exceeded that made in all previous time; and would probably during the present generation yield still more startling results. In speaking of the laws of origination and variation, he referred to the work of Mr. C. Darwin, "On the Origin of Species," a work which he said was "as perfect in its logical method as it was accurate in its scientific facts," though he did not pledge himself to all Mr. Darwin's results. In conclusion, he stated that he felt bound to make use of his present position, to urge upon the University authorities the claims of biology as a recognized study, and the practical encouragement of it by the bestowal of some of those fellowships which were so ungrudgingly given for proficiency in mathematics and classics.

As Professor Huxley had included both Universities in his appeal, Dr. Daubeny, F.R.S., rose, and stated that at Oxford such fellowships were given for natural science, as he could affirm (from his own knowledge) to be the case, at least at Magdalen College, to which he belonged.

Rev. William N. Molesworth, M.A.: "On the Influence of Conditions of Existence in modifying the Characters of Species and Varieties." The author said that a theory which should combine all the observed facts of palæontology, distribution, &c., and scientifically grapple with the origin of species, had long been a desideratum; and, although he wished to appear neither as an advocate nor an opponent of Darwin, he believed that that gentleman had been unjustly accused of making a wanton attack upon beliefs and feelings which ought to be respected. He condemned the introduction of scriptural matters into scientific investigations, and urged that science need never come into collision with moral and religious truth. He thought, however, that there was a point on which Darwin might have laid more stress, viz., upon the changes which were continually taking place in the conditions of animal existence, and the necessity of the variations which arose out of those changes; so that the being might be able to keep in harmony with the conditions of its existence.

The Rev. Professor Kingsley entirely concurred, as a brother clergyman, with what Mr. Molesworth had said about the ill-founded charge of materialism which had been made against Mr. Darwin.

J. Crawfurd, F.R.S.: "On Colour as a Test of the Races of Man." Colour, in different races, appeared to be a character imprinted upon them from the beginning, because, as far as our experience goes, neither time, nor climate, nor locality has produced any change. Egyptian paintings, 4,000 years old, represent the people as they are now. The Parsees of India, who went from Persia, are now the same as when they migrated 1,000 years ago. African Negroes, that have for three centuries been transported to the New World, remain unchanged. The Spaniards settled in tropical America remain as fair as the people of Arragon and Andalusia. He contended that climate had no influence in determining colour in different races. Finns and Lapps, though farther north, are darker than Swedes; and, within the Arctic circle, we find Esquimaux of the same colour and complexion as the Malays under the equator. Yellow Hottentots and Bushmen live in the immediate neighbourhood of black Caffres and Negroes. There is as wide a difference between the colour of an

African Negro and a European, between a Hindoo and a Chinese, and between an Australian and a Red American, as there is between the species of wolves, jackals, and foxes.

Sir Charles Nicholson could not agree with Mr. Crawfurd's conclusions. The variety of the human races, as they now are, has, doubtless, existed for a long time; and tombs of very great antiquity showed this. But there is now in India a race of Jews perfectly black; and in China, the Jews had long become the same in physiognomy with the Chinese, though the Jews never intermarry with them. Among the natives of America there is an evident approximation to the Red Indian in physiognomy, for they were assuming the hatchet-face, and losing the beard. The same effect could be discerned among the European population of Australia; and Sir Charles stated his opinion that the question was to be settled on philological rather than on ethnological grounds. (The black Jews, to whom Sir C. Nicholson referred, are well known to be the descendants of Hindoo proselytes, and not of Jewish extraction, and they look up to white Jews as to a superior people.)

The discussion of greatest interest in this Section was raised upon a paper, by Professor Owen, F.R.S., "On the Zoological Significance of the Brain and Limb Characters of Man; with Remarks on the Cast of the Brain of the Gorilla." The Professor exhibited two casts; one of a human brain hardened in spirits, the other taken from the *interior of the cranium* of a gorilla,—and described the peculiarities of each. He remarked that these were so marked as clearly to distinguish them generically. In the brain of man the posterior lobes of the cerebrum overlapped the cerebellum (or smaller brain) to a considerable extent, whereas, in the gorilla, these posterior lobes did not project beyond the lobes of the cerebellum; that is to say, that in man the posterior lobes were prominent, whereas in the gorilla they were deficient. From long and close investigation into the characters of animals, he was convinced that the *brain* offered the most constant characters; and he had, therefore, proposed, in a paper read before the Linnæan Society, in 1858, to recast the mammalian groups—classifying them according to their cerebral development. Man, besides having a remarkable prominence of the posterior lobes, also possessed a part termed a *posterior cornu*, or horn, of the lateral ventricles, and another portion, termed the *hippocampus minor*, in this posterior cornu. The distinctions between this type of brain and that found in the other mammalia were so well marked that he had placed man in a distinct sub-kingdom. The brain he considered a far better guide in classification than the foot; but, nevertheless, as great difference was observable in the latter as in the former.

Professor Huxley said that the paper just read in no way appeared to represent the real nature of the question under discussion, which he would state in another way. That question was twofold—one of facts, viz., What are the structural differences between man and the higher apes? and one of reasoning, viz., What is the systematic value of these facts? Professor Owen had now for several years made three distinct assertions respecting the first question of facts,—assertions which he had repeated in the present paper. These assertions he had reiterated without modification or qualification of any kind. He (Professor Huxley), on the other hand, affirmed that the three assertions of Professor Owen were groundless, inasmuch as the three structures spoken of were, instead of being *peculiar* to the human brain, often *better developed* in the higher apes than in man. He deprecated the present discussion as useless and full of evil, but he was bound to take up the challenge that had been thus thrown down to him. He believed, however, that the differences between man and the lower animals are those of the moral and intellectual faculties, and are not to be expressed by physical differences in his toes or his brain.

Professor Rolleston, F.R.S., said, it had been abundantly shown that the *hippocampus minor* and the posterior lobe were insufficient as differential points, and must be given up at last. He regretted that the labours of Gratiolet had been ignored in this discussion, a circumstance little creditable to British science. He had proved that the differences between the brain of man and the ape were: 1st, its greater absolute weight; 2nd, its greater absolute height; and 3rd, the multifidity of the frontal lobes corresponding to the forehead, usually (and correctly) taken as a fair exponent of man's intelligence. It was to the *front* rather than to the back of the brain that he should look for the distinguishing characteristics of man. But Professor Owen had made no allusion to these important matters.

Mr. W. H. Flower, F.R.C.S., conservator of the museum of the College of Surgeons, said that, looking at the subject solely from an anatomical point of view, and as a question of fact, the result of his dissection of a larger number of monkeys' brains than had perhaps fallen to the lot of any one else present was, that the parts referred to by Professor Owen as peculiar to man are, in reality, proportionately *more largely* developed in many monkeys. If these parts were to be used in the classification of the mammalia, the series would be,—first, the little South-American marmosets; next the baboons; then the cercopithecs, the magots; *then* MAN, followed by the orang-outang, chimpanzee, and gorilla; and last the American howling monkey.

Dr. Humphry thought that slight difference of structure might lead to vast functional results, and that a moral hiatus might be greatly out of proportion to any mere physical distinction.

After a few words from Professor Owen, in reply to Professor Rolleston, the discussion ceased.

(During this discussion the writer had an opportunity of examining a dissected brain of a cercopithec in spirits, which Mr. Flower chanced to have with him, and in which the posterior cornu and hippocampus minor were very distinctly visible.)

Mr. James Samuelson: "Recent Experiments on Heterogenesis, or Spontaneous Generation." The author communicated the results derived from the simultaneous exposure of various kinds of infusions prepared by him in Hull, Paris, and Liverpool. Amongst these results the following afford fresh evidence against the theory of spontaneous generation, and tend to prove the existence of innumerable germs of life in the atmosphere.

Dr. Balbiani (the author's coadjutor in Paris) found certain well-defined species of infusoria in his infusions, which he also discovered in the moistened dust from his window; and another well-marked species, found in large numbers by Dr. Balbiani in his infusions in Paris, was traced by Mr. Samuelson, first in moistened dust from the high road near Liverpool, then in dust taken from his own window and washed in distilled water, and lastly even in pure, boiled, distilled water, after it had been exposed a few days, in the open air, in Liverpool. The author watched and carefully described the development of this species (*Cercomonas acuminata*) from its first appearance to its full growth. These experiments will, we believe, be published shortly, with illustrations.

Dr. Davy, F.R.S.: "Observations on the Earthworm." These observations went to show that the coloured fluid, or blood of *Lumbricus terrestris*, served for the purposes both of nutrition and aëration or respiration, and were confirmed by a series of experiments. Dr. Davy considered the blood to be a receptacle for oxygen, which is stored up in it to supply the requirements of the worm.

Dr. Cobbold, F.L.S.: "Remarks on all the known Forms of human Entozoa." The author exhibited drawings, and described the structure, habits, and mode of development of thirty species of intestinal parasites which infest the human body; one of these (*Bilharzia hæmatobia*) was common to man and monkeys, exclusively. He showed the possibility of checking the progress of several fatal entozöotic diseases, and he appealed to this Association to aid him in experimental research upon this important subject; and described the enormous destruction of human life in Iceland, arising from the introduction of entozoa into the body. (Subsequently, in the Committee-Room, a committee was appointed, and a sum of money voted for the investigation of this subject.)

Dr. Collingwood, F.L.S.: "Report of the Committee for advancing Science by means of the Mercantile Marine." The writer stated that the paper read by him at Manchester: "On the Opportunities of advancing Science enjoyed by the Mercantile Marine," and then ordered to be printed, had been extensively circulated in England and America, and was furnished by the direction of the Committee of Council on Education to all the Government Navigation Schools. The Literary and Philosophical Society of Liverpool had created a new class of members, termed *Associates*, to include captains and mates of merchant vessels, as an encouragement and reward of any endeavour they might make to advance science; * and meeting of the leading shipowners of that port had had the subject laid before them, and had approved of the suggestions which had been made. A publication addressed to the members of the Mercantile Marine had been issued by the same society, containing plain and concise directions how to study, and how to preserve the animals which came under their notice, with a reference also to the most useful books, and most simple apparatus for that purpose. It was intended to circulate this pamphlet among the officers of merchant vessels; and it was hoped that important results would follow in course of time.

The subject of this Report was then discussed by Professor Huxley,

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* We would recommend the Society to add to the honour thus conferred a more tangible reward, such as a medal.

[illegible] F.R.S., Dr. [illegible] F.R.S., Rev. [illegible], and [illegible] importance of the movement, and [illegible] in the hands of [illegible].

[illegible] M.D., F.R.S.: "On the Physiological Effects of Bromide of [illegible]." The author [illegible] his experiments, in saying [illegible] power of diminishing [illegible]. He [illegible] the Extinction of [illegible] more [illegible] substance at [illegible].

[illegible] Davy, M.D., F.R.S.: "On the Scientific Cultivation of the Salmon Fisheries." Dr. Davy showed how these fisheries had been neglected in this country, and pointed out the manner in which they should be improved. [illegible] in Ireland the annual value of salmon fisheries was £[illegible], and in Scotland one single fishery, belonging to the Duke of Richmond, was valued at £[illegible]; the total value of the English and Welsh fisheries was only £[illegible]. Dr. Davy proceeded to describe the improvements made at Galway, by means of which, in ten years, the fishery had been rendered ten times as productive; and 3,000 fish had been taken with the rod during the present season. The preservation of the streams *during the breeding season*, at a cost of £500, had chiefly led to this result, aided by the introduction of young artificially-bred salmon, into streams fitted for them, but from which the fish had been previously excluded, owing to impediments preventing their access to the sea. These impediments had been removed by the construction of ladders; by means of which, in Sligo, for example, a fall of forty feet had been rendered easily surmountable by the salmon, so that, by this means, a previously barren river had been made to yield, in one week of July last, 1,000 fish.

Professor Kingsley and Professor Huxley commented upon the importance of this subject, and remarked that there was no reason why salmon should not be the abundant fish and the valuable article of diet to the lower classes that it had been in days gone by.

Dr. Davy also read a paper "On the Vitality of Fishes," which our limited space prevents us from reporting.

Gilbert Child, M.D.: "On Marriages of Consanguinity." Distrusting the ordinary statistical mode of examining the question, he believed that experiments on the lower animals were conclusive in proving that degeneracy did not result from in-and-in breeding. He held that there is positive evidence, from the results of recorded observations upon animals, that no such law affects them; that is, that where other causes of degeneracy are absent, any degree of close breeding may exist, without producing ill effects; and he argued, that unless we are prepared to believe in two distinct physiologies, the same must be true of the human race.

The President, Dr. Paget, opposed these conclusions, as being contrary to fact; and denied that the comparison between the lower animals and man in this respect held good.

Dr. Gray, F.R.S.: "On the Change of [illegible] of Crocodiles, and on the Crocodiles of India a[illegible] arisen among the species of crocodiles, from the error of some naturalists regarding the young and the adult as different species—an error arising from the short and rounded form of the face when first hatched. In process of growth, however, the muzzle elongates, and the bones increase in size for supporting the teeth. The author remarked that this well illustrated the necessity of studying all the kinds of animals in every stage of their growth. No species could be said to have been properly observed until all these circumstances had been duly examined and noted; and though the notice of a single individual, or state of an animal, was certainly of value, it could only be regarded as a sign-post, indicating the existence of an animal which required further study and examination. Dr. Gray went on to point out that great confusion had arisen among the species of Crocodiles and Alligators. The character of the "teeth fitted into notches in the margin" was one, however, which was peculiar to crocodiles, and not common to both; nor is the African crocodile found in India, as supposed.

R. Garner, F.L.S.: "On Pearls: their Parasitic Origin." Mr. Garner had examined the pearls formed in the Conway and Lancashire mussel; not the beautiful pearls of the Alasmadon, from the Upper Conway, at Llanrwst, but those of the salt-water mussel. He attributed the same origin to all pearls, viz., the deposit of eggs by a minute species of Distoma, causing their formation much in the same way as galls are formed in plants.

Dr. Cobbold was not ready to accept Mr. Garner's explanation, for he had not seen the Distoma within the pearl, nor investigated the anatomy of the parasite; and knew not, therefore, whether it was a perfect Distoma or a larva.

Mr. Garner replied that the pearls of Alasmadon are not diseased ova, for it has its ova in the foot and gills, where the pearls do not occur; nor are they produced in the renal organs. They might be produced by grains of sand, &c., but then such foreign bodies could not get access to the mantle, as it is attached all round to the shell; and on splitting a pearl no grain of sand is found, but a little dark-coloured animal matter, which he considered to be the remains of the Distoma, its exuviæ, &c. In the Lancashire mussels, the Distoma was always to be found as a little yellow speck (to the naked eye) enclosed in a condensed cellular envelope, and sometimes might be found in a calcifying state. He did not think he was called upon to follow out the anatomy of the parasite.

Professor Rolleston, F.R.S.: "Diastase in the Saliva, and its Action upon Starch and Inuline." Inuline, a kind of starch found in the dahlia, artichoke, &c., differs from true starch in not being changed into sugar by the converting agency of the diastase contained in the saliva, unless, indeed, it contains sugar at first. Moreover, the saliva of infants contains so small an amount of diastase, that even common starch is inconvertible by it, and therefore innutritious. Important practical results follow from this; first, that artichokes cannot be used as a substitute for potatoes, since they contain inuline instead of starch; and second, starch foods are useless in the early months of infancy, since the salivary diastase at such ed is inactive.

SCIENCE SCHOOLS AND CLASSES.

In the List of Science Teachers contained in our last Number we mentioned the name of Mr. H. P. Meaden, Haslingden, near Manchester, as having passed nine students with first-class Queen's prizes.—It should have been ten.

We have to add that before the last examination there were 158 Science Teachers in Great Britain, and four Lecturers holding honorary diplomas. Their names will be found at the end of the last Directory published for the Science and Art Department, South Kensington Museum.

We mention this, as we know of persons who have been desirous of obtaining instruction in elementary science, and were quite unaware that there was an able teacher resident in their immediate vicinity.

REVIEWS.

BRITISH CONCHOLOGY.*

AT the commencement of his volume, Mr. Jeffreys refers to the expensive character of the "British Mollusca," by Professor E. Forbes and Mr. Hanley, as a reason for his having undertaken the present work. No such apology was needed: naturalists who know anything of the enthusiasm of the author for his subject, and of the zeal with which, for many years, he has devoted himself to his favourite study, would have had cause for much regret if the materials thus collected had been withheld from the public, or were only to be found scattered in the many communications made by him to various scientific societies.

To afford some idea of the research undertaken in preparation for the present work, we may refer to the author's account of his investigations relating to a single genus of small fresh-water bivalves:—

> "My own cabinet contains no less than 274 parcels of *Pisidia*, which have been in the course of the last thirty or forty years collected from different localities and sources, and comprise many thousands of specimens. I have personally examined the types of those species which have been described by Dr. Turton, Mr. Jenyns, Mr. Alder, Dr. Bandon, and other conchologists who have published on the subject. I have collected these tiny shells in many parts of Holland, Germany, France, Switzerland, and Italy, for the sake of comparison with British forms; and I have had to refer to numerous works in many languages in order to collate the descriptions of forty-one different species which have been proposed by European writers within the last century. Of these I cannot conscientiously recognize more than six as distinct."

Although the volume now published is confined to land and fresh-water shells, the Introduction, extending to 114 pages, is quite general, and affords space for the description, in a very readable form, of most of the questions interesting to conchologists. Without expressing a decided opinion on the "origin of species," Mr. Jeffreys suggests a practical method of distinguishing between species and varieties. He says:—

> "I believe it may now be considered a well-established rule that all distinct groups of individuals, living together, and having a common feeding-ground, and which are not connected or blended with each other by insensible gradations, are *primâ facie* entitled to the rank of species."

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* *British Conchology.* Part I.—Land and Fresh-water Shells. By JOHN GWYN JEFFREYS, F.R.S., &c. Van Voorst. 1862.

Selected on this principle, the author recognizes 121 species of British land and fresh-water molluscs; the number given in the "British Mollusca" being 125. This slight reduction in the number of species accredited to our native land is, however, far more than compensated for by the acknowledgment of no less than 187 distinct varieties, all of which are named and described; whilst, of a large proportion, the localities and other circumstances of interest are recorded.

The name of a new species had, until recently, something almost magical in its attractions. Collectors were deemed fortunate who could secure the prize; its absence from a cabinet was regarded as leaving an unsightly gap; whilst varieties, however curious or distinct, were counted as little more than superfluous luxuries. Thanks mainly to Mr. Darwin, this disparity is at an end, and collectors are now in a position better to appreciate the value of labours such as those of the author, and of the large increase he has made in the number of recognized objects of attention on the part of those who desire to study the land and fresh-water shells of our country.

In the more difficult genera Mr. Jeffreys has, we think, succeeded in presenting the species in bolder and better relief than any previous writer. For example, the genus *Zonites*; the descriptions of *Z. nitidus*, *Z. alliarius*, *Z. purus*, *Z. nitidulus*, *Z. radiatulus*, ought to leave collectors in no difficulty in identifying these snails, even without the assistance of plates.

In nomenclature the author seems to us in a few instances to have needlessly increased the difficulty of the subject by the adoption of unfamiliar names, having only a questionable claim to priority; and by alterations in orthography induced by his desire to render all the generic names significant. A mere name is at all times a most fallacious guide to the determination of a species, and young collectors, to whom alone the caution need be addressed, should in no instance affix a name on account of its supposed agreement with a specimen under examination. It is far more honourable, and in every way better for scientific purposes, to attach the place, date, and, if possible, the circumstances of its capture, and to wait patiently till it can be satisfactorily identified.

In the work before us, for *Balea* of Dr. Gray, the more recent *Balia* of Swainson is adopted, as nearer "badius," a somewhat barbarous Latin word for "brown," which is, after all, a wholly unimportant indication. If the supposed meaning of a name is to give a clue to its orthography, we can well imagine the erudition which may hereafter be called into exercise by future conchologists pondering upon such titles as those of Dr. Gray's genera "Lottia" and "Pollia," the investigators being, after all, certain to hit upon no meaning half so pleasant as the fair originals.

In one instance Mr. Jeffreys has for a well-established name, "*Pupa Anglica*" of Ferussac, substituted one of his own, "*Pupa ringens*" Jeffreys, on the plea of having been the first to describe the species, though previously figured under the familiar name; and this whilst, on his own showing, the name *Pupa ringens* had been used by M. Michaud for other species of the same genus. All possible consideration will, however, doubtless be extended to the author when it is understood that the vindication of his own discoveries presents itself to him in the aspect of a "parental duty" (p. 267).

In many respects the present work appears to us to be far in advance of any previous one upon the subject. Together with clear, concise, and sufficient descriptions of the characters which serve to distinguish the species, are combined so many interesting observations on the habits of the animals, that the work possesses the rare merit of combining scientific accuracy with a large amount of popular instruction. We can only give one or two brief illustrations. It is well known that certain univalves, when suddenly dislodged from floating weeds, spin a thread by which, like the spider, they are able to regain their resting-places. Mr. Jeffreys records a similar habit in *Sphærium lacustre* (*Cyclas caliculata*), which also uses its foot in ascending the sides of an aquarium, and even in creeping along, suspended from the surface of the water, just in the manner common to many gasteropods. Bivalves, with the exception, perhaps, of some species of oyster, are supposed to be purely aquatic in their habits; yet the author records, on the authority of Nilson, that *Pisidium pusillum* is in Sweden frequently found living between the bark and the wood of fallen trees in moist places. *Helix pulchella*, a minute snail common in Britain, is reported to occur in Siberia, Italy, Corsica, Madeira, North America, Cashmir, and Thibet. Some of our little wood-snails, *H. aculeata* and *H. fusca*, appear, on the Continent, to adopt habits not generally known in this country: they ascend in spring the trunks of trees, live during the summer amongst the higher branches, and in the autumn save themselves a long and laborious descending journey, by dropping with the falling leaves to their place of winter retreat.

The snail has not generally found much favour in the eyes of poets; yet the author avails himself of the assistance of a friend to devote some pages to the æsthetic aspect of his subject, with especial view, as he asserts, to the gratification of his fair readers. Homer, Göethe, and "Shakspere," are cited. From the "Venus and Adonis" of the last-named a fine simile is given:—

> "Or as the snail whose tender horns being hit,
> Shrinks backward in his shelly cave with pain,
> And there, all smother'd up, in shade doth sit,
> Long after fearing to creep forth again;
> So at his bloody view her eyes are fled
> Into the deep dark caverns of her head."

We anticipate with pleasure the volumes on the "Marine Mollusca of Britain," by the same author, and conclude this brief notice with a word of commendation for artist and publisher. Mr. Sowerby's plates, more especially the beautiful coloured frontispiece, deserve special notice; and of Mr. Van Voorst we can only repeat what has been said a hundred times before,—that what ink and paper can do to render useful reading pleasant, he has done.

WASTE PRODUCTS AND UNDEVELOPED SUBSTANCES.[*]

AT the present period, commerce is making such demands for increased supplies of various substances, that scientific men are carefully studying the residue of every manufacture, and the special qualities of each new product. At such a time, then, a book like the one before us is of peculiar value, and we have read with much pleasure and interest this work of Mr. P. L. Simmonds on Waste Products and Undeveloped Substances, a book aptly described by the author as affording "hints for enterprise in neglected fields,"—hints which do not refer so particularly to waste materials, but serve specially as directions by which to guide the student into new fields of inquiry as regards the utilitarian applications of natural productions generally. It would be difficult to define what is "waste" in the present day, so admirably and completely are the many substances, formerly neglected and thrown away, now utilized and converted into new and valuable products. A greater field, however, for the commercial as well as scientific inquirer is that afforded by undeveloped substances. It is now, when the word "substitute" is ringing like a battle-cry, that men's thoughts are directed to every variety of produce; and week after week vessels bring from different quarters of the globe woods, containing new tints for the dyer, or novel combinations of colour and figure for the cabinetmaker; fibres of a special character; seeds producing new descriptions of oils; leaves, roots, &c., of unknown medicinal power. In fact, the world has revived once more the art of the alchemist, the attempt to transmute baser materials into more precious ones; and no discovery ever made by the old chemists equalled or even approached the results which have been obtained from substances considered for ages as "waste." It is, however, only within the present century that we are seriously applying the example which nature has been teaching us ever since the first seed-time and harvest, and we have yet much to learn. There is no waste in nature; decay is but a name for the life of new and often beautiful creations. Death begins life, as well as ends it, and no agencies in nature are suffered to waste. The changes which organic life undergoes are but the links leading from one organism to another, and in this transmutation there is no waste, no loss, but perfect harmony of arrangement, by which the life ending in death becomes the death merging into a new existence.

We purpose considering the subject of Waste, and afterwards inquiring into Undeveloped substances. As refuse materials, Mr. Simmonds enumerates a very interesting and lengthy list of articles, which, becoming waste, are by various manipulations changed into new and frequently very re-

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ste *Products and Undeveloped Substances.* By P. L. SIMMONDS. 1862.

markable products. Rags take a very prominent place in the catalogue, and really there is no material which contributes more largely to the transformation scenes of commerce than the cast-off clothing of humanity. By a variety of processes, the rags thrown away by the poorest beggar reappear in the clothing of the sailor, the labourer, or even of the gentleman; or, after passing through the sad history of St. Giles, are met with, tinted *couleur de rose*, in a lady's boudoir in St. James's. Few people not engaged in it are aware of the value and importance of the rag trade. Mr. Simmonds estimates that cotton and linen rags, to the amount of above £300,000, are imported annually, and that "the whole quantity used in the kingdom exceeds £1,000,000." Rags are imported from the various countries of Europe, from the northern part of Africa, from India, and from Australia, America consuming more than her own population can supply.* Linen and cotton rags are used in the manufacture of paper; woollen are converted into shoddy and mungo. An extract from an article on Yorkshire in the *Westminster Review*, quoted by Mr. Simmonds, gives an excellent definition of shoddy,† and an interesting list of its applications is added. It is estimated that the value of shoddy and mungo amounts to above £700,000 annually.

Shoddy is another name for rag-wool, and it was probably first used for purposes of manufacture about 1813; but machines for reducing woollen rags to small particles appear to have been known in London before they were employed in Yorkshire. The shoddy trade is a large one on the Continent. At Berlin several establishments have been formed by Batley manufacturers for making rag-wool. Prussia levies a heavy export-duty on rags, but none on shoddy; hence we receive about 8,000 tons annually, *viâ* Hull, from Prussia, Denmark, &c. In the collection of products from Denmark in the International Exhibition, an interesting series of samples of shoddy were shown. It is estimated that this trade employs 600 persons in Batley alone.

Old woollen rags also form an important feature in the manufacture of prussiate of potash, a chemical largely used in blue colours, in making Prussian-blue, and also cyanide of potassium, which is employed in electroplating with gold and silver. Woollen rags are also used as a manure in the Kentish hop-gardens, 2½ lb. being considered equal to 100 lb. of farmyard manure. The agriculturalists of Italy have long been in the habit of planting old woollen garments at the roots of their orange-trees.

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* The perusal of this notice of Mr. Simmonds's book induced us to look at a "Foreign Rag Circular," published by a Liverpool firm, and we there found that, during the month of November last, 11,000 bales of rags (representing about £35,000), were exported from Liverpool and London to New York. These rags had been imported into England chiefly from Egypt, India, and Japan! This circular quoted the prices of about fifty different varieties of foreign rags, varying in value from nine shillings to forty shillings per hundred-weight, imported from Egypt, Japan, Bombay, Beyrout, Hamburg, Palermo, Leghorn, Trieste, Smyrna, Spain, and Valparaiso. There are many other places from which rags are imported. —Ed.

† P. 302.

The cotton-wads, with which engineers clean their machinery, are afterwards worked up into some descriptions of shoddy. Cotton-waste, "the refuse cotton of the mills," is another article of considerable importance, it being manufactured into writing and printing paper; whilst in America it is made into an imitation of papier mâché.

Oakum made from old ropes, again, is the product of a waste substance. Mr. Simmonds states that 1,400 tons, valued at £28,000, are sold annually in Liverpool. The total imports of codilla or tow (the waste fibres which occur in the cleansing of hemp and flax), amounted in 1857 to 13,000 tons, valued at £373,000. It is manufactured into bags, yarn, &c.

Bones form another waste product, though no longer wasted, and Mr. Simmonds gives a very interesting account of the changes which they undergo. Bones are made into manure as superphosphate of lime, or turned into handles for knives, fans, tooth-brushes, umbrellas; or converted into buttons, children's rattles, &c. They are also largely used in the manufacture of animal charcoal (a very important agent in refining sugar). Bones are boiled for the sake of the gelatine which they contain, and this gelatine is used by dyers, and not unfrequently by cooks; the fatty matter obtained being made into soap. The value of bones imported and collected at home is calculated to amount to £700,000 per annum.

This book contains one of the most interesting biographies, that of a dealer in refuse bread, bread crumbs, crusts, &c., which has ever come under our notice.

We must glance rapidly over the list of waste substances, and refer our readers to the complete and varied information which Mr. Simmonds supplies on each subject.

The saw-dust of various woods is a waste product of importance, and employed for a variety of purposes. The husk of the grape, after the fruit has been crushed, is used in making a weaker wine, and also in the manufacture of vinegar. Oil-cakes, formed from seeds after the oil has been crushed from them, are of great commercial importance.

We must not omit to mention another waste material—the waste paper of the Government offices, which sells annually for £7,000.

Dead dogs in Paris and New York are no longer wasted, they are boiled down, and their fat used in the preparation of kid-gloves. Old horses form a perfect mine of wealth, and Mr. Simmonds gives a very curious list of the purposes to which their "remains" are applied.

The waste products of coal show perhaps the most extraordinary results of chemical researches. Gas-water, formerly allowed to run to waste, is now eagerly bought up. The residual products of coal are very numerous, and amongst them are ammoniacal-water, employed in making sulphate and carbonate of ammonia, sal-ammoniac, and alum; coal-tar, which contains a variety of products; naphtha, employed as a solvent, and for burning purposes; benzol, the basis of the endless shades of mauve, Magenta, roseine, &c. Another product is paraffin-wax, which is made into candles; and another creosote, from which carbolic acid is obtained, largely used as an antiseptic. Carbolic, in combination with nitric, produces picric acid, from which are obtained the beautiful greens and yellows so much in fash

Undeveloped substances afford a still wider and more important field; for every new and untried product comes, of course, under this denomination. Researches are being constantly made, in order to find substances which may contain qualities similar to those already known, but which may be rare and costly. This inquiry opens a new world in which an endless variety of products offer themselves, first as luxuries, but finally as necessities.

Mr. Simmonds's book is especially interesting on this subject, and many of his suggestions are of easy application.

A great variety of substances have been developed as substitutes for sugar; and we need scarcely refer to the substitutes for cotton. Fibres of every description have been suggested, one of the latest being the delicate fibre of the *Zostera marina;* but all proposed substitutes appear to possess three difficulties—short supply, increased cost of manufacture, and inadequate result. The substitutes for tea are very numerous, and many of them somewhat peculiar. We need not specially refer to sloe-leaves, and Mr. Simmonds gives us the satisfactory assurance, "that the great bulk of the tea imported into this country for the last ten years has been unadulterated." Upwards of ninety-eight different plants have been cultivated in various parts of the world as substitutes for tea.

The products of the *Palmaceæ* have never yet been fully developed. In its fruits, nuts, oils, fibres, sugar, spirit, woods, flour, wax, canes, &c., we have a most wonderful variety; but this family contains materials, the qualities of which are not known. It is only of late years that the kernel of the palm-oil nut, *Elæis Guineensis*, has been crushed for the sake of its oil, and this oil now realizes a higher price than that of the fruit. The kernel of the Cohune-nut, *Attalea Cohune*, produces a most brilliant oil, and a series of experiments have lately been tried with it. The Palms produce many fibres which have not yet been tested. A most beautiful specimen was shown in the Exhibition,—so fine in its character, that it looked like human hair.

Mr. Simmonds draws attention to new edible roots, and mentions a large variety. Amongst others, the root-stocks of the Arrowhead, so common in our streams; the roots of various species of the Arum; the bulbous roots of the Star of Bethlehem. In Germany, the roots of the dandelion are consumed. The pig-nut, *Bunium flexuosum*, is well known in England, and might be made an important article of food. The tubers of a species of *Oxalis* have been imported from Peru, and found equal in quality to the potato; and the *Journal de Chambery*, quoted by Mr. Simmonds, states, that the bitter principle in the dahlia can be removed by boiling, and that the root can be used as a substitute for the potato.

Fibres and their substitutes have a chapter to themselves. The beautiful silk cotton of the West Indies has not been employed for weaving purposes, on account of the want of staple. In America it is used in the manufacture of hats. Very beautiful fibres have been obtained from the leaves of the pine-apple and stems of the banana. The aloe, of Mexico, now supplies a very important material, known as Mexican Fibre, and largely used in making into brushes, imitation horsehair, &c.

The substitutes for rags in the manufacture of paper form a most curious [illegible] respecting new substances [illegible]. We must refer our readers to this chapter [illegible] is inclined to ask [illegible] the manufacture of paper. [illegible] patent was taken out for [illegible] lately introduced [illegible]

[illegible] refer to the economic [illegible] manufacture of iodine, [illegible] for fabrics, &c.? [illegible] chapter on the [illegible] of the Waste of the [illegible] attention to this [illegible]

[illegible] business information [illegible] relating to the [illegible] rather than a dry [illegible]"

A Plain and Easy Account of British Fungi. By M. C. Cooke, Author of "A Manual of Structural Botany," "A Manual of Botanic Terms," *&c.* [illegible] coloured Plates. London: Robert Hardwicke.

THE author of this volume is already favourably known as having written a "A Manual of Structural Botany." It is introductory to the more elaborate works of Schleiden, Henfrey, Balfour, Lindley, Hooker, &c.; and we have no hesitation in saying that it is the very best and cheapest manual which can be placed in the hands of a beginner.

Mr. Cooke writes for those whose education and means are limited, and with pre-eminent success. It is really a pleasure to read the manuals which he has published, for they are up to the mark, and so complete as to leave hardly anything to be desired.

This new work on the Fungi appears to be equally valuable with those which he has already printed. It contains descriptions of the esculent fungi, the manner in which they are prepared for the table, how to discriminate the nutritious from the poisonous species, details of the principles of their scientific classification, and a tabular arrangement of orders and genera.

It is very creditable to Mr. Cooke that the drawings in his book are all sketches from nature, made by his own pencil. This shows work, and is more respectable than the too common practice of copying engravings from the authorities in the particular branch of science.

This little book is valuable because, in some respects, it is certainly a good guide book to a number of edible fungi unknown to the public. Unfortunately, our author has not given us the time of the year when they may be [illegible] has left this to conjecture. If found at all seasons, he [illegible]; if peculiar to the autumnal months, the fact ought to have been mentioned at the close of the description. In this respect the book is not "a plain and easy account of British fungi." We are surprised at such an omission. We know that some fungi are peculiar to autumn, and others may be found at all seasons of the year. The author had better mention the time when the fungi are most abundant. It will render his book more available.

Dr. Badham, who has written a work on the esculent fungi of Britain, is quoted by Mr. Cooke as saying:—

> "I have this autumn myself witnessed whole hundred-weights of rich wholesome diet rotting under trees; woods teeming with food, and not one hand to gather it; and this, perhaps, in the midst of potato-blight, poverty, and all manner of privations, and public prayers against imminent famine. I have, indeed, grieved when I have considered the straitened condition of the lower orders this year, to see pounds innumerable of extempore beef-steaks growing on our oaks, in the shape of *Fistulina hepatica; Agaricus flavipes*, to pickle, in clusters, under them; puff-balls, which some of our friends have not inaptly compared to sweetbread for the rich delicacy of their unassisted flavour; *Hydna* as good as oysters, which they somewhat resemble in taste; *Agaricus deliciosus*, reminding us of tender lamb-kidney; the beautiful yellow *Chantarelle*, growing by the bushel, and no basket but our own to pick up a few specimens in our way; the sweet nutty *Boletus*, in vain calling himself *edulis*, where there was none to believe him; the dainty *Orcella;* the *Agaricus heterophyllus*, which tastes like the crawfish when grilled; the red and green species of *Agaricus*, to cook in any way, and equally good in all."

We are afraid, after such a development as this, that some of the purchasers of Mr. Cooke's volume will be hurrying off to the woods, expecting to find "tender lamb-kidney," "beef-steak," "grilled crawfish," and "oysters" under the trees, and that they will probably come home disappointed.

The author has, however, carefully drawn and described several of the fungi mentioned in this rather strongly-worded passage,—the extempore beef-steak, *Fistulina hepatica*, and the tender lamb-kidney mushroom, *Agaricus deliciosus*, for example. The latter, according to our author, is now called *Lactarius deliciosus*.

As this book may very possibly fall into the hands of persons who may have occasionally some difficulty in procuring a family beef-steak, we sincerely hope they will be successful in finding the extempore one, *Fistulina hepatica*, which our author has carefully figured, and thus describes:—

> "*Fistulina hepatica* (*hepar*, Lat., the liver), from its colour, which resembles that of the liver. This fungus assumes a great variety of forms. In its earliest stages it sometimes looks like a strawberry; when more advanced, it has often the appearance of a tongue. One of its continental local names is *Lingua di Castagna*, which applies to this resemblance. It is a fleshy juicy fungus, with an undivided unstalked pileus, and when cut, presents a bright streaky appearance, not unlike beetroot, and contains a red juice; the porous under-surface is yellowish or flesh-coloured. The trunks of old oaks are very commonly the habitat of this species, which occasionally attains a very large size. When old it becomes rather tough, but in all its stages it affords an excellent gravy, and when young,

if sliced and grilled, would pass for a good beef-steak. Specimens are now and then met with that would furnish four or five men with a good dinner. The liver-colour and streaky interior are sufficient guides whereby to recognize this species under all its protean forms."

We agree with Mr. Cooke, that the fungi are deserving of a far greater share of public attention than they have hitherto received, "as articles of food," and we think that his book is well calculated to incite to their study.

Speaking of the sub-genus *Tricholoma*, our author says:—

"It is extremely probable that this group does not contain a single unwholesome species, and it certainly contains several with very fair esculent properties. The whole of these, and indeed, almost every species except the common mushroom, are characterized by the majority of our countrymen, as 'toadstools.' Let us hope that such names, which were originated and have been perpetuated in ignorance, will soon become extinct."

We are afraid that the author will long have slept beneath the "daisy-sod of Britain" before this state of things will be realized. Nevertheless his book cannot fail to do good. There is truth in its pages, and the knowledge imparted by them is calculated not only to add new dainties to the table of the rich, but to enable the poor to provide nutritious food for their families when other means fail them, at certain seasons of the year.

We have little doubt too, from the accuracy of Mr. Cooke's previous works, that this volume on the British Fungi is a *safe* as well as "plain and easy guide" to these plants. He says that—

"The number of poisonous species has been greatly exaggerated; but of these there are many, and the properties of a few are extremely virulent. We have always imagined it prudent to taste unknown species with caution, since we have learnt that some mycologists, having perhaps more enthusiasm than caution, have, from merely tasting very virulent species, suffered for some time afterwards considerable pain and inconvenience."

In default of general rules, our author recommends no one to experiment on species which are unknown, or which he has not pointed out as safe.

"It is not advisable to venture upon such as have a decidedly acrid taste in the raw state, unless they are known to be edible. One or two species which possess such properties when uncooked, are wholesome when dressed; but there are exceptions to the general rule. If only such species are employed as we have described in the foregoing pages, and delineated in the plates, there is no fear of unpleasant results."

The author thus writes about his cookery of the *Lycoperdon giganteum*:—

"A gardener brought us a large puff-ball, equal in size to a half-quartern loaf, and which was still in its young and pulpy state, of a beautiful creamy whiteness when cut. It had been found developing itself in a garden at Highgate, and to the finder its virtues were unknown. We b [illegible] ecimen cut in slices, about half an inch in thickness, the [illegible] led off, and each slice dipped in an egg which had been [illegible] sprinkled with bread-crumbs, and fried in butter with salt and pepper. The result was exceedingly satisfactory; and finding this immense fungus more than our family could consume whilst it remained fresh, we invited our friends to partake, and they were as delighted as ourselves with the new breakfast relish, to them and to us—the first, but we hope not the last experiment upon a fried puff-ball."

Mr. Cooke employs such excellent material, that we are not surprised that he can make a good dish out of a puff-ball. His skill reminds us of French cookery, which is so celebrated for its metamorphosis into excellent eating of what to an Englishman would be exceedingly unpalatable.

Allowing for a certain amount of enthusiasm so pardonable in Mr. Cooke as a naturalist, we cheerfully commend the book to public favour, as probably containing much that is true, and we think that money may be saved and no person's health endangered by its purchase, careful perusal, and a trial of its numerous suggestions.

The Microscope and its Revelations. By W. B. CARPENTER, M.D., F.R.S., &c. Third Edition. Churchill.

THIS new edition of Dr. Carpenter's work contains an account of the most recent researches of microscopical writers and observers, and although it is many years since the first edition was published, this still remains the best text-book of microscopical science extant, and (together with Mr. Van Voorst's Micrographic Dictionary) forms the best existing guide for all classes of students.

SCIENTIFIC SUMMARY.

QUARTERLY RETROSPECT.

ASTRONOMY.

DURING the long nights of the winter months, the telescopic observer is much busier than at other seasons of the year; and although the present quarter has been far from favourable, yet a few discoveries have been made which are somewhat important. M. D'Arrest has inaugurated the erection of a large Munich refractor, at Copenhagen, by the discovery of the seventy-sixth individual of the group of planets revolving round the sun between Mars and Jupiter. His successor at the Leipzic Observatory—M. Bruhns—has signally distinguished himself as the discoverer of *two* comets within a few hours of each other, and thus proved that this branch of astronomy is equally safe in his hands as in those of M. D'Arrest, so famous for his successful search after those bodies. In this, however, M. Bruhns is only following up his previous well-earned renown at the Berlin Observatory, where he detected many comets. By the public in general those discoveries are looked upon as the result of chance; but this is far from being the case, the search being as systematic as any that can possibly take place under the circumstances. Previous to finding either a planet or comet, the sky has to be sounded, surveyed and triangulated with the greatest accuracy—variable stars and nebulæ avoided, and marked with as great care as the rocks and breakers of the ocean—and the result has been that within the last ten years the maps of the smaller telescopic stars are far more correct than those which are visible to the naked eye. It would appear probable that the list of planets is now nearly full,—the perfection of the star-maps does not seem to have any effect in adding to their number, although it is by this perfection that any loose straggler is in momentary danger of being detected. Of late years, those planetary "nuggets" have been found few and far between, contrasting strongly with the rich harvest gathered some years since by MM. Hind, Goldschmidt, and Gasparis. In regard to comets the case is otherwise, and we may always expect an average annual supply of those bodies. In consequence of cloudy weather and moonlight, neither of the new comets has been favourably seen in this country, so that we must defer any further notice of them for the present.

Daphne.—The planet Daphne has been searched for during the last e or four years with great anxiety, but no tidings heard of it until the last hs, when Dr. Luther detected an object of the eleventh magnitude (on August 31), which turned out to be the missing planet. During the search instituted for it, another planet (the 56th of the asteroids) was detected, which received the name of *Pseudo*-Daphne. This asteroid has, therefore, the distinguished honour of being No. 41, No. 56, and No. 75, of the group of asteroids, two of which numerals it must now be contented to relinquish. From observations on August 31, September 5, and September 11, there can be no doubt of its identity with the original object. Pseudo-Daphne has received the name of *Melete;* the planets 73 and 74 discovered on April 7 and August 29 respectively, being called *Clytia* and *Galatea.*

Lunar Mountains.—Mr. Birt has detected a remarkable chain of lunar craters which have been overlooked by Mädler and Schröter, and whose positions are not given in any other maps of the moon. They are situated on the surface of the Mare Tranquillitatis, being the highest portion of the wall between Menelaus to a point opposite Plinius, and situated on the southern border of the Mare Serenitatis. It is very seldom that they can be advantageously seen, and Mr. Birt was only able to observe them in 1861, April 16, and 1862, May 5 and October 29. On May 5, 1862, he noticed that there were three deep craters, hardly distinguishable from each other, being quite in shadow; two rocks and another crater, which is isolated from the further continuation of this wall, were also seen, they being all situated at the end of the promontory called Acherusia. Mr. Birt has recognized other discrepancies in Beer and Mädler's maps, but does not consider them to be real changes, the great difficulty of seeing them fully accounting for their omission.

The Elchies Telescope.—The great equatorial of Ross, furnished with a telescope of eleven inches aperture and sixteen feet of focal length, has been almost lost sight of since its appearance at the Exhibition of 1851. It has of late years been in the possession of J. W. Grant, Esq., of Elchies, Morayshire, who, however, has been unable to make as much use of it as he could wish, or as his former success with a five-foot telescope in India would lead one to anticipate—he having with the latter instrument discovered the companion to Antares two years before Professor Mitchell, who was furnished with the great Cincinnati refractor.

Professor Smyth, who examined the optical and mechanical arrangements of the Elchies telescope, reports highly on both qualities. When it is considered that one portion of the stand alone weighs eleven tons, its firmness and absence from tremor may be imagined. In the double star 28 Aquilæ, Professor Smyth detected a new or third companion, which is an exceedingly faint object, at nearly the same distance from the large star as the other one. In the triple star Delta Aquilæ, the closer companion was identified, but it was found that it had decreased in brilliancy, from the twelfth magnitude in 1833, to the sixteenth in 1862. Two new stars of the fifteenth magnitude were detected at 61 and 107 seconds from the principal star in the beautiful system of Beta Cygni. A faint companion of the same magnitude was discovered within 70 seconds of Zeta Sagittæ. New stars were also detected in the neighbourhood of 452 Cygni and 1 Pegasi, at the respective distances of 98 and 80 seconds from the principal star, and three new ones were found to accompany 312 Pegasi, at the distances of 81, 106, and 127 seconds respectively. In the star 222 Arietis, great changes have taken place since 1834,—the principal star of the sixth magnitude, and visible to the naked eye, having vanished completely; whilst the three others, which in 1834 were of the fifteenth, tenth, and ninth magnitudes respectively, when viewed through the Elchies telescope, were found to be two of the twelfth, and the last of seven and a half magnitudes. This may serve as an example of the continual and usually unnoticed changes which are taking place in the heavens. As a crucial experiment of the defining power of the telescope, it may be stated that the blue star of Gamma Andromedæ was completely and more than separated. Scarcely more than half a dozen of the best instruments in the world at the present time would be able to effect this separation.

Great Comet of 1861.—The Rev. Mr. Webb has recently given the result of his observations on the comet of 1861, in regard to the nucleus, envelopes, the luminous sector or fan, the coma, and the tail. The envelopes were the most remarkable portion of the comet, particularly on the night of June 30, when the effect produced was compared to a number of light, hazy clouds, floating around a miniature full moon, and when portions of six of various lengths and degrees of curvature could be distinctly traced. From a general *résumé* of his observations made up to July 23, Mr. Webb is of opinion that as no phase was visible in the nucleus, that this part "either contained no concentration of opaque matter or shone by intrinsic light." The axial rotation of the nucleus also seems improbable, but it would appear probable that there was some amount of libration if we were to judge by the swinging motion of the sector. The latter was of later date than the envelopes and much posterior to the perihelion passage; as the comet retreated from the sun, the envelopes descended on the nucleus, and caused perhaps the increasing apparent density of the whole coma. No indications of rotation were perceived in the tail. The angle which the sector and envelopes made with the axis of the tail would lead one to suppose that a stronger repulsion or a less resisted emissive force acted in one direction from the nucleus than in the opposite. The nebulous veils were always seen better on one side than on the other, but from the position of the comet in its orbit no satisfactory deductions can be made in this respect.

According to wishes expressed by correspondents, we append the elements of the first and second comets of this year.—The first, discovered by M. Schmidt, at Athens, on July 2, near the stars Beta, Rho, and Sigma Cassiopeiæ, was at its shortest distance from the sun on June 22, 5· 43, Greenwich mean time. The longitudes of node and perihelion were respectively 324° 30′ and 298° 35′. The inclination was 8° 14′, the motion retrograde, and the logarithm of least distance 9·992. The second comet of 1862 passed its perihelion on August 23, 7·1 Berlin mean time, the longitudes of node and perihelion being 137° 5′ and 344° 16½′, the inclination of orbit 66° 3′; motion retrograde, and the logarithm of least distance being 9·985.

Companion to Procyon.—The existence of dark stars in the heavens, which controlled the motions of those visible to the eye, which idea is due to Bessel, was good-humouredly ridiculed by Humboldt in his corre- ce with the former. It is now, however, made a matter of calculation, in at least two stars, Sirius and Procyon. In respect to the former star, Peters in 1851 found that the irregularities in its position could be explained by the motion of the bright star about an invisible one, the latter being in uniform motion.

In respect to Procyon, Bessel's hypothesis has also been confirmed, and a binary system in which Procyon moves about a dark star in an orbit whose plane is that of the visible heavens, the distance between the components being about a second and a quarter. The actual distance of Procyon from the Sun being approximately known, M. Auwers concludes that the mass of the dark body is about one-half of that of the Sun, and in any case the mass of the dark body must be at least a hundred times as great as that of Jupiter. If Procyon and its companion have equal masses, that of each would be greater than $\frac{37}{100}$ths of the Sun; and if the mass of Procyon is equal to that of the Sun, that of its companion must be greater than $9\frac{6}{10}$ths that of the Sun.

Mars.—By observations made at the Oxford Observatory between September 18 and October 26 of the present year, Mr. Main has determined the ratio of the polar to the equatorial diameters of Mars as 38 to 39, being almost exactly the same as found by Arago, and which has been so much doubted. On September 30, the ellipticity was found as 245 to 244, and on October 17, as 29 to 28, which are the extremes. For the equatorial diameter at the unit of the distance, Mr. Main finds 9″·38, giving a real diameter to the planet of 4,332 miles.

Comet II. of 1862.—This comet was observed at Hobart Town until September 21, with the naked eye, at which time, of course, it was not at all visible in the north of Europe. Mr. Knott found variations in the position of the luminous sector to the extent of more than fifty degrees.

Star-Cluster in the Southern Cross.—This object, described by Sir John Herschel as resembling a splendid piece of jewellery (the stars in it being compared, from their various and beautiful tints, to sapphires, rubies, topaz, and emeralds), appears to have greatly altered of late years: one has changed, according to the careful observations of Mr. Abbott, from greenish-white to bluish-purple; another from green to pale cobalt; another from green to ultramarine, &c. The colour of stars is, however, so variously judged by different eyes, that probably the above discrepancies are due more to different estimations than any real change.

Suspected Variable Star.—In searching for one of Herschel's triple stars, which could not be recognized as such by Struve, with the great Dorpat telescope, Mr. Dawes immediately perceived the looked-for companion, which was equally unseen by South, Sir John Herschel, and Smyth. From the fact of its being invisible for eighty years in powerful instruments and well-trained observers, and seen in the present year with a telescope of four inches aperture, Mr. Dawes thinks it desirable that it should be put down upon the list of suspected variables. The position of this object is R.A., 19h. 29m.; N.P.D., 106° 32′; the magnitudes, according to Mr. Dawes, 6½, 8, and 11¼.

Large Meteor.—A huge *bolide* made its appearance on November 27, which was visible in all parts of the British Islands and France. As seen by the writer, it appeared as a huge globe of fire of a balloon shape, almost if not quite as large as the Moon, though in other respects bearing no resemblance to that body, being of a hazy contour, emitting a dazzling blue light at first, which became afterwards of a yellowish tint. Although visible for only a few seconds, no person in the open air at the time could fail to notice it as it came out of the sky with the quickness of a flash of lightning, and disappeared equally suddenly, its course being in the direction from Mars to the Moon. We hope in our next to be able to give some account of its track and height.

The *Comptes Rendus*, November 17, contain a letter from P. Secchi to M. Elie de Beaumont, concerning the planet Mars, in which the former states, that there can be no doubt that the white polar blotches on that planet are masses of snow, or of clouds condensed at the poles; that the persistence of the blue channels show them to be seas, and the red patches continents.

The comet first discovered by M. Bruhns will be visible in those latitudes during the month of January. On January 1, 1863, it will be close to the star Kappa Coronæ (of 4½ mag.), and not far distant from the star Zeta (of 4th mag.). It travels after this to the constellation of Vulpecula, and is close to Flamsteed 25 on January 28 (of 6th mag.). It is at its greatest brilliancy on January 1.

The second comet has disappeared at present, but may probably be visible at the end of February. It likewise is at its greatest brilliancy on January 1. On February 17, it is in the constellation of Cetus.

BOTANY.

Artificial Formation of Cork.—M. Casimir de Candolle, the third of that name, describes the mode by which, in Algeria, superior cork is obtained from the cork oak. The rough corky layer is removed down to the subjacent cellular envelope, or green layer, during summer and autumn. In consequence of this removal a new corky stratum forms upon the green layer at a variable distance from its denuded surface. This stratum grows in annual layers upon its internal surface, just as the original worthless corky layer did; but it is much finer, and more elastic. After seven or eight years it is sufficiently grown to be removed, and the same process is repeated. This may be done many times, and new cork removed every seven years to an almost indefinite extent.

The Exhalation of Ozone by Plants.—In the *Comptes Rendus*, M. Kosman details experiments from which he deduces these results: That plants disengage ozonised oxygen from their green parts, during the day, in greater ponderable quantity than exists in air. During the night the same thing takes place, if accumulated masses of vegetation are in vigorous growth. Town plants disengage less ozone during the day than country plants; hence the air of the country is more *vivifiant*. In the midst of the town there is more ozone in the air at night than during the day. The corollas, or coloured parts of the flower, do not disengage ozonised oxygen; and, lastly, in inhabited rooms, oxygen does not generally exist in an ozonised state.

Hybrid Plants returning to their Original Species.—M. Naudin, having fertilized plants of Datura stramonium with others of D. Tatula, afterwards sowed the seeds produced by this union, and obtained hybrids of the first generation. These hybrids were isolated; and a few seeds coming to maturity, they were sown in April, 1862, and produced twenty-two plants of the second generation, viz., five of Datura stramonium in all its purity, whose fruits ripened and came to maturity; and nine typical plants of Datura tatula. The remainder were more or less of a hybrid character. M. Naudin believes that this third generation of the hybrids will turn completely to D. tatula. These remarkable facts, which demonstrate the fact of the spontaneous disappearance of fertile hybrids, without the intervention of a crossing with one or other of the parent species, appear to M. Naudin at present inexplicable.

Acclimatisation of Japanese Plants.—M. Simon, writing from Japan, continues to recommend valuable plants for introduction into the *Jardin d'Acclimatisation*. The hemp palm (*Chamærops excelsa*) bears a temperature of 10° Fahrenheit, requiring no particular care. The stalk of each leaf is covered with filaments of various fineness, of which the coarsest are used for ropes, and the finer for nets. Another plant he speaks of is the *soja*, a kind of bean used by the Japanese for a condiment, and a very savoury adjunct to almost every Japanese dish.

The Sago Palm.—Mr. Wallace, who has returned, laden with valuable information, from his Eastern travels, speaks of the sago palm as the staff of life to the inhabitants of New Guinea and the adjacent islands. He described it as a truly extraordinary sight to behold a whole tree trunk converted into human food, with as little labour as is required to convert corn into bread. A single good tree will produce six hundred pounds of sago cakes; and with an expenditure of ten days' labour, a man may produce food sufficient for a year's consumption. The natural result is improvidence, laziness, degradation, and misery.

Botany of North Yorkshire.—Local floras and local faunas being of great value and importance, we gladly notice the preparation of a work to include the flora of this interesting part of England. North Yorkshire stands midway between the North and South of Britain, and can claim for its own about three in four British species. About 1,600 species of flowering plants, ferns, and mosses will be described; and as a valuable adjunct, sets of the rare and critical plants of the district are prepared, containing each about one hundred specimens.

The Cotton Substitute.—The substance proposed by Mr. Harben, and spoken of in our last as favourably mentioned as a substitute for cotton, has now long been known to be the fibre obtained from the Grass Wrack (*Zostera marina*). The subject has since that time been before the public, and well canvassed by practical men. The result, at present, appears to be that, although it may prove useful as a supplement to cotton, or for mixing with other fabrics, neither the nature of the fibre, nor the source of its supply, renders it probable that it can make us independent of the cotton-plant.

***The Potato Disease.*—Dr. de Bary, of Freibourg, has recently published a pamphlet containing an epitome of all that is known regarding the potato disease, and gives the results of his observations. He finds the theory of its being due to a parasitical growth to be correct. A seed or spore of the parasite, when placed in the leaf, he says, will penetrate the tissue in twelve hours, and in sixteen hours it bursts through the leaf, and is ready to reproduce itself at the rate of 19,620 zoospores for every square line of its surface.**

CHEMISTRY.

PURE CHEMISTRY.—Among the various matters of scientific interest, we may notice the experiments of M. Robinet, with reference to the purity of ice. It appears that water is rendered almost as pure by congelation as by distillation ; the calcareous and magnesian salts being forced out, in the act of freezing, as completely as the more soluble salts. He states that frozen water may be used for most chemical purposes in place of distilled water. Dr. Rüdorff has found that when a saline solution has frozen to such an extent that there is not sufficient water remaining to hold the salt in solution, it crystallizes.

A new method of preparing hyposulphuric acid has been described by Gelis ; it consists in acting on sulphurous acid with hydrated peroxide of iron ; the peroxide is suspended in water and sulphurous acid-gas passed into the solution where a compound of sulphurous acid and peroxide of iron is formed, which decomposes in a short time into hyposulphate and sulphite of protoxide of iron.

Mendius has found that when the nitrites are exposed to nascent hydrogen, a transformation takes place, and an amine base of the next higher homologous alcohol formed ; the method of proceeding was to act on a mixture of the nitrite with sulphuric acid by metallic zincs ; by this method hydrocyanic acid, acetonitrile, butyolonitrile, and benzonitrile, were transformed into methylamine, ethylamine, amylamine, and a new base of the composition, C_7H_9N.

The conversion of aldehyd into alcohol by means of nascent hydrogen has been accomplished by Wurtz. To effect the change, all that is necessary is to expose a dilute solution of aldehyd in water to the action of an amalgam of sodium, when part of the aldehyd becomes resinified and the other part combines with hydrogen, to form a body possessing all the properties of ordinary alcohol.

This process of transformation of organic bodies by the introduction of nascent hydrogen seems to be of general application, for Linneman has changed sugar into mannite, by acting with sodium amalgam on cane sugar, which has been changed to grape sugar by sulphuric acid ; and benzoic and valerianic aldehyds have been converted by Friedel into benzoic and valerianic alcohols.

Mr. J. J. André has lately studied the action of chromic acid on vegetable alkaloids. He has found that definite crystallizable compounds can be prepared, but that great care is requisite to prevent a reduction of the chromic acid taking place; quinine and brucine combine in two proportions with chromic acid, but cinchonine, quinidine, and strychnine form only one compound, for on adding a solution of neutral chromate of potash to a solution of a salt of one of these bases, a portion of the base was precipitated from the solution, and the neutral chromate of the base was found in the filtrate.

The formation of organic compounds by synthesis is highly interesting, inasmuch as it is a great onward step to the investigation of the processes by which these bodies are naturally formed. The number of such transformations is rapidly increasing, and no doubt eventually some light will be thrown on the changes that occur during the growth of animals and vegetables, and the formation of the complex and varied organic bodies found in their different parts. The formation of acetylene by the passage of an electric spark between two charcoal points, placed in an atmosphere of hydrogen, is of great interest, inasmuch as it is formed by the synthesis of its elements without the pre-existence of an organic body; and starting from this substance a whole series of organic bodies may be formed by further synthesis, as has been shown by Berthelot, who made the discovery of the synthesis of acetylene.

An interesting communication by Mr. E. Dancer has been read before the Chemical Society, "On Hypobromous Acid," in which the author has demonstrated, by most conclusive experiments, the chemical properties of this body. He did not succeed in preparing hypobromous anhydride, but found that the hydrated acid could be produced by the action of bromine water upon the red oxide of mercury, similarly to hypochlorous acid, to which it had a great analogy, possessing also powerful bleaching properties. This body was also formed by the action of bromine upon nitrate of silver, as had been previously shown by Mr. Spiller. It was impossible to prepare a more concentrated solution than that containing six per cent.: partial decomposition ensued on distillation at ordinary pressures, but by the aid of the air-pump this could be prevented. With dilute solutions of the caustic alkalies, bromine gave rise to the production of bleaching solutions, containing soluble hypobromites, but with concentrated solutions bromates and bromides were formed.

The General Medical Council, after some deliberation, have resolved to leave the grain weight unaltered, and to retain the avoirdupois pound and ounce, but to discontinue the use of the drachm and scruple in the Pharmacopœia. The confusion occasioned by the introduction of new weights, and the difficulty of adapting old formulæ to a new system, are objections to a change in the standard weights; but considering the numbers of different systems of weights and measures now existing, the introduction of a decimal notation would afford an immense simplification, and possibly prevent many mistakes.

Dr. Sheridan Muspratt has recently made analyses of the waters of the mineral springs of Scarborough, from which it would appear that there has been some mistake as to the comparative medicinal properties of the north and south springs, the north spring being richer in magnesian salts, but containing less iron than the south.

The results of the analysis are expressed in the following tables:—

	North. Cubic inches.	South. Cubic inches.
Nitrogen	7·4864	7·9792
Carbonic acid	43·3112	38·0408

Mean temperature of the water, 48°

	Grains.	Grains.
Carbonate of lime	42·354	34·846
Carbonate of magnesia	2·844	3·051
Carbonate of iron	1·465	1·996
Carbonate of manganese	trace	trace
Sulphate of magnesia	98·952	90·992
Sulphate of lime	69·120	69·537
Sulphate of soda	7·060	2·015
Chloride of sodium	19·287	19·540
Chloride of potassium	3·002	2·416
Chloride of magnesium	1·941	0·920
Silicic acid	0·859	1·063
Organic matter, &c.	traces	traces
	246·884	226·376
Sp. gr. of the water	1·0033069	1·0028378

A process for the preparation of silicated hydrogen in considerable quantities has lately been brought into notice. Dr. Martius has been engaged in making metallic magnesium by reduction of the chloride with sodium; for this purpose he employed an earthen crucible, and on examining the product he found that it contained silicium, and gave off inflammable gas during solution in hydrochloric acid. By introducing larger quantities of silicium he was able to prepare the gas in a state of greater purity; it possesses, like phosphoretted hydrogen, the singular property of spontaneous inflammability.

It is generally stated, in books on chemistry, that camphor has a tendency to deposit towards the light, by which it is meant, that if a bottle containing camphor be exposed to sunlight, the camphor will be deposited in crystals on that part of the bottle which is turned towards the light. Mr. C. Tomlinson's experiments however have led him to the conclusion that heat, not light, is the cause of the phenomena observed. He exposed a great number of bottles of camphor to light under different circumstances (for instance, when immersed in water), and found that no deposit was formed under those conditions that prevented a radiation of heat.

II. Applied Chemistry.—A patent has been recently taken out by Mr. James Webster, for a process for making oxygen gas from nitrate of soda, and at the same time obtaining certain other valuable products. The process consists in heating a mixture of the nitrate with oxide of zinc in retorts; the nitric acid is decomposed by the heat into oxygen and nitrogen, the soda remaining behind, is separated by water from the oxide of zinc. It is proposed to employ the oxygen in metallurgical operations, and for the production of light; the soda will be very valuable in soap-making, and for many other purposes to which this substance is applied.

A new method of preparing iodine from seaweeds has been suggested by Mr. M'Ardle; it consists in fermenting the plants in water until the organic matter is destroyed, when the inorganic salts will be left behind; a considerable saving is effected by this process, for in the old method of burning the seaweeds some of the iodides are volatilized and lost.

The American oil-wells still continue to furnish large quantities of petroleum, which has become an important article of commerce. It has been proposed to employ it in the manufacture of illuminating gas. Experiments have been made for the purpose of ascertaining the amount of gas furnished by the destructive distillation, the oil being allowed to fall into a heated retort, together with a little water. The result was satisfactory. A great advantage in the gas prepared in this manner over coal-gas would be, that it would be free from sulphur compounds, and would not require so much purification.

Although a great many processes for rendering textile fabrics fire-proof have been proposed, a really good method for accomplishing this end is still a desideratum: it is rather difficult to find a substance that answers the purpose completely, is cheap, and does not injure the fabric in any manner. It is not necessary to render the material altogether incombustible; but only that it should be difficult to inflame, and that, when removed from the fire, it should either cease to burn, or at least should only smoulder. When it is remembered that ladies lose their lives at the rate of 750 per annum for the sake of their skirts, the importance of the subject will readily be admitted.

Until quite recently, methylated spirit was supposed to be undrinkable; a careful investigation having been made by eminent chemists for the purpose of ascertaining whether or not it could be rendered potable by chemical processes, the answer seemed to be decidedly in the negative, at least with respect to any wholesale purification of the article. This has, however, been accomplished by Mr. Eschwage. He simply passes the liquid through a succession of charcoal filters, which remove the unpleasant smell and taste. The only part of the process which is claimed in the patent is the management of the filters, which are so arranged, that when the first becomes exhausted it is removed and replaced by the next in order, and the new filter made the last in the series, so that each filter is worked until it is completely exhausted. The peculiar flavour of the methylic spirit is almost perfectly removed by this treatment, so that it could be employed without detriment for medicines, &c. Some druggists, however, seem to have no scruples in employing the impure and disagreeable liquid in the manufacture of medicinal tinctures. The consequences of this are most unpleasant, both to the patient who has the misfortune to take the medicine, and to the physician who prescribes it. Draughts, intended to stop sickness, and quiet the stomach, have quite the opposite effect, and dangerous results ensue.

So little of the unpleasant taste and odour of the methylic spirit remains after the charcoal treatment, that the addition of any flavouring material completely conceals it; and as the apparatus, once fitted up, involves no great expense, it becomes a question whether the addition of wood spirit alcohol will any longer prevent its being employed in the manufacture spirituous drinks, so that the ultimate result would seem to be disadvant geous rather than otherwise, for it will put a stop to the sale of methylat spirit, free of duty, for the manufacture of varnish and other commerci purposes.

M. Regnault has described a method of recording the temperature ar pressure in balloon ascents, without observation of the aëronaut. Tl apparatus consists of a series of tubular reservoirs, with capillary tub proceeding from them; at the end of each capillary tube a larger tub filled with chloride of calcium is fixed, so that only dry air can enter tl reservoir. These constitute the thermometric system. The barometr consists of a similar series, with their reservoirs immersed in melting ic In order to insure the temperature of the ice remaining constant in tl extreme cold of the upper regions, it is recommended to surround tl vessel containing the ice with another vessel containing warm water starting. The tubes are numbered to correspond in each series. To dete termine the temperature and pressure at any moment, it is necessary close the stop-cocks of one tube in each series simultaneously, the balloo not being in rapid motion at the time. The density of the air contained i the tubes is afterwards determined, from which both the temperature ar pressure at the time of closing can be deduced.

GEOLOGY AND PALÆONTOLOGY.

A YEAR or two ago no geological doctrine was believed to be bett demonstrated than that which declares granite to be a fire-form rock. The generalization agreed well with the theory known as Laplace —really Sir W. Herschel's—of the consolidation and cooling of tl earth from a fiery state, which most mathematicians and geologis accept; and was submitted to such complete discussion in the famou war of Wernerians and Huttonians, that the possibility of the idea bein imperfect or wrong was never suspected. In the days of its adoption, how ever, and indeed till recently, the earth's crust was regarded as a mere eg shell of some ten miles thickness, which any Plutonic disturbance migl pierce; but latterly the central fluid mass has been placed at greater an greater depths, till now there is probably no one who regards it as likely th fluid rock is forced up to the surface of the earth from its centre. Then cam the researches of Mr. Sorby on the microscopic structure of igneous an intrusive rocks; and, as is well-known, the occurrence of cavities co taining water and a bubble of air, in their constituent crystals, led hi to conclude that the temperature at which granite was produced could n have been excessively high, and that water in a heated state was not abser from it when formed. And now Professor Harkness has added further t the evidence, and drawn a most important conclusion, destined we believ to be generally adopted. Whilst examining metamorphic strata in th ıds of Scotland, he has found that the *strike* of the Plutonic mass is with that of the metamorphic rocks, and accordingly infe that in that district at least, Plutonic masses do not perform the office of axes in elevations. The general idea is that the granitic rocks pushing up from below have bent up the over-lying stratified beds like the thatch on a hayrick; but this view received a rude shock some time since, when Mr. Selwyn discovered, in Victoria, granitic masses which pierce old strata without affecting their dip, the dip on one side being coincident with that on the other side. And now, in Sutherland and Banffshire, Mr. Harkness believes the facts to indicate, that the water-formed deposits were upheaved, flexured, and contorted, prior to the period when granites made their appearance in them. And, finally, he tells us in so many words that, as regards its origin, there are "abundant features which would support the conclusion that granite is, in that district, rather the result of an excessive amount of metamorphic action than a Plutonic rock." What these "abundant features" are, it would have been interesting to have learnt; but one that could not have been undervalued is the existence of the metamorphic rock gneiss. Knowing as everyone does that that seeming granitic substance is really an altered sedimentary deposit, it only needs the hint to comprehend that the difference between granite and gneiss is one of degree and not of kind; that these differ much less from each other than does gneiss from a water-formed rock; and, therefore, when all the preceding facts are remembered, it requires no stretch of the faith to lead to the conclusion that similar forces to those which produce metamorphic strata, only operating through longer periods or in greater intensity, may have formed granite. This would account for the correspondence of *strike*, the coincidence of *dip*, the presence of water-globules, and many another otherwise unaccountable circumstance; while it makes no demand on the assistance of deep-seated central forces. It is nowise our function to follow this thesis further, but the reader will probably see that if satisfactorily demonstrated, it will necessitate a new theory of the elevation and depression of land.

The origin of river valleys has long been a moot point. With that pertinacity which always characterizes scientific wars, one school has maintained that rivers erode their own channels, while the other party, triumphantly pointing to instances where streams go out of their way to pass through mountains, has held that they found the general features of their courses ready formed. In this state of our knowledge, or rather ignorance, Mr. Jukes comes forward to solve the riddle. His explanation is extremely startling, but probably in its general features true. Before giving an analysis, however, it will be but fair to say that, in our judgment, the new doctrine is not yet fully proved; and that the essay in question, though philosophically conceived, and written with clearness, errs in sometimes regarding complex and debateable theories as axioms.

The district selected for typical illustration is the South of Ireland, the central plain of which is carboniferous limestone, some 300 feet high. And to the south of it are several ranges of hills, some made of the subjacent old red sandstone and Cambro-Silurian, others of the superimposed Coal rocks, and it is from these that the streams to be mentioned rise.

In the case of every river examined, including the Shannon, Blackwater, Lee, and many others, it becomes evident that they could not possibly have excavated their valleys since the limestone attained its present low level; for, in every case, after draining the upper part of a valley, the river, instead of following its natural and shortest course over the lowest land to the sea, turns aside to cut through high bluffs of old red sandstone or older strata; and if these deep channels were dammed up to the height of 200 or 300 feet, the rivers, instead of toppling over the obstructions, would have taken widely different courses. Yet Mr. Jukes, finding that these ravines are not along lines of faults or fissures, and failing to detect any signs of dislocation, believes that the existing rivers have worn their channels through the hills.

Now, because there are many valleys in the "old red" exhibiting highly inclined carboniferous strata resting conformably on it, the conclusion is legitimately drawn, that the rocks of these parallel latitudinal valleys were once continuous, and have been denuded subsequent to the age when both systems of strata were thrown into great lateral folds. Similarly, because the isolated mountains of coal measures have the same dip and contain the same fossils, it is regarded as demonstrated—not only that the solitary hills were once connected by intervening rock of the same kind, but that the coal deposits once extended continuously over all the limestone. All this vast thickness of several thousand feet has then been removed; and hence the ridges formed by contortion have all been cut off, and the country so far converted into a plain; and it might be easily shown that this denudation could only be accomplished by the sea. Mr. Jukes believes that in all cases where the country is flat, and the beds are not horizontal, the open sea, by long continued action over it, has, "like a gigantic planing machine," removed the elevations.

And thus it becomes evident that approximately the land rose up as a flat, over which, from the beginning of the upheaval, the drainage will have flowed from the peaks to the sea. And this necessarily implies that the deep valleys in the old red sandstone containing carboniferous limestone did not then exist, but that the carboniferous and old red rocks were at the same level. And the point of the paper is, that the wasting action of the atmosphere and rain is regarded as the cause which has removed the whole mass of the limestone to a depth of 300 feet, and so formed the valleys. For had these valleys been filled up, the rivers would have taken their present courses over the old red sandstone to the sea; and as the river and atmosphere acting together would necessarily be a more potent power than the atmosphere alone, it is conceived that the rivers would deepen their beds faster than the rate at which the level of the limestone descended. But as these limestone valleys were formed, they produced lateral rivers of their own, flowing to the east, and these were, of course, received as tributaries where they reached the original steam; but from draining a much larger area, the feeder was larger than the river, and now has the appearance of being the river itself.

Such is the theory; and it certainly accounts satisfactorily for the existence of the deep tortuous ravines through which the rivers flow. While there is no difficulty in the thickness of rock removed, except the ifling consideration of the lapse of time it must represent, for in county

Clare, blocks of limestone, which formed part of a bed two or three feet thick, have been wasted by the atmosphere, till all now left to represent them are mere cakes an inch or two thick.

It is believed that this great atmospheric denudation has been going on ever since the carboniferous period; for, excepting the depression during the glacial epoch, Mr. Jukes regards it as certain that the South of Ireland has been dry and high continuously from that time.

Should this explanation be generally accepted, of course it must be applied to the rivers of the Weald, and many in the North of England; while it will at the same time be conceded that all the minor features of the districts are the result of a gradual action on the soluble rocks, like the melting of a jelly-fish in the sun.

The *remains of a large placental mammal* have been detected in the upper greensand by Mr. Harry Seeley.

Preservation of Fossil Shells.—It is well known that shells often consist of two distinct layers; an outer one secreted by the margin of the investing membrane called the mantle, and an inner pearly layer secreted by the whole of the mantle. The pearly layer is composed of the form of carbonate of lime crystallizing prismatically, called aragonite, while the outer layer is often the other, or rhombohedral form, called calcite. And it has for some time been observed empirically, that the shells of the Chalk have all lost their inner layers; while in some other deposits, such as the Portland oolite, Cambridge greensand, &c., multitudes of the fossils have lost the whole of their shells, and exist only as moulds, while some other genera existing with them, and often nearly allied, always have the shell preserved. This has induced Mr. Sorby to make experiments on a large number of recent and fossil shells; and as the result, he finds that when the shell is preserved it is in every case *calcite.* And that shells in the state of aragonite, such as Trigonia, always have a tendency to become crystalline by taking the form of calcite; and if in this change the conditions are more favourable for crystallization in some other place rather than *in situ* the shell disappears altogether.

MECHANICAL SCIENCE.

The Middle Level Drain.—That necessity is the mother of invention is nowhere more frequently illustrated than in engineering practice, and the inundation of Marshland, in consequence of the undermining of the quicksand foundation of the great outfall sluice of the Middle Level drain, has caused the engineer to resort to several novel expedients; one or two of which from their value and ingenuity deserve permanent record. The drainage waters of the Middle Level district are conveyed through Marshland to the Ouse by the Middle Level drain, which had at its termination an outfall sluice with three openings, each twenty feet wide, to permit the discharge of the drainage at low water, and to prevent the reflux of the tide. During March and May last, the bank at the wing-wall of the sluice was undermined, and gave way, admitting the tide to the drain, and, subsequently, by the failure of its banks, to the Marshland district which has a separate drainage. It is not necessary here to narrate the series of unsuccessful attempts to stay the progress of the flood. In the end, Mr. Hawkshaw succeeded in forming a dam which has kept out the tide by constructing two parallel walls across the drain, consisting of close piles, extended gradually from each side towards the centre where an opening of ninety feet was left. Across this opening twin piles were driven, at distances of about seven feet from pair to pair, and with a space of eight and a half inches between the piles of each pair. In the groove between the twin piles massive panels were dropped at the ebb, when the flood on the lands was at its lowest. The panels were sufficiently strong to prevent the ingress of the tide, until by filling up the space between the two rows of piling with puddle, and dropping barge-loads of chalk and stone against their interior and seaward faces, the temporary dam was converted into an impervious and durable embankment. It now remained to draw off the waters from the flooded land, and to provide for the future exit of the drainage waters of the Middle Level, which otherwise in winter would have endangered the rescued lands as much as the tide had done before. For this purpose, Mr. Hawkshaw has adopted six immense iron syphons, the number of which is to be increased to fifteen. Each syphon consists of a tube three feet six inches in diameter and 150 feet long, which rising from the lowest level on the landward face of the embankment, bend over its crest and dip down to the foot on the seaward face. They have valves at each end which permit the flow of the water from the drain towards the sea whenever the tide has fallen, so that the level of the water in the drain is above that outside; but prevent its reflux on the return of the tide. A ten horse-power steam-engine and air-pumps are employed to exhaust the air from the syphons, both that originally in them and that continually disengaged from the water. About 50,000 gallons of water per minute are said to be discharged by the six syphons already constructed.

Mr. Thorold has suggested the employment in future, in works of this kind, of a duplicate sluice at the back of the sea-sluice, for the purpose of keeping up a head of water, at an intermediate height, between the two sluices, when the sea-sluice is closed by the tide; so that the hydrostatic pressure may be distributed over twice as many supports as hitherto.

Dr. Grimaldi has introduced *a form of boiler*, similar in many respects to the old multitubular, but in which the system of tubes is maintained in slow revolution about the axis of the boiler. The generation of steam is more effective than with fixed heating surfaces, and the boiler space for a given quantity of steam may be reduced one-half. A small engine has been constructed in America, in which the boiler considered as a reservoir of steam is dispensed with. The steam is generated at the instant it is required in a small vessel thirteen inches diameter by thirty inches long, into which the feed water, previously heated by the exhaust steam, is admitted in measured quantities and in the form of spray. This spray impinging on highly heated metallic surfaces, flashes into steam and is superheated. No doubt on this plan some of the sources of danger and waste which exist in [illegible] steam-engines are avoided, but a most serious defect is probably at the same time introduced, one which has hitherto proved fatal to the success of the air, or so called caloric engine ;—viz.: the inefficiency of the furnace.

We discovered, soon after writing our last notice, that one of the *Lenoir motors* was exhibited at South Kensington, and occasionally at work there. It appears to be a perfectly successful application of the force of the explosion of measured volumes of coal gas and air, fired within the cylinder, by the ignition of the poles of a galvanic broken circuit at each end.

Renewed attempts have been made to form an *alloy of nickel and iron*, similar to that found naturally in meteoric iron, which is known to possess great malleability and strength. During the Russian war, Mr. Fairbairn made experiments on various alloys of nickel with cast iron, but without obtaining any increase of strength. More recently, Mr. Longmaid has succeeded in alloying nickel with iron in the puddling furnace, producing a material more nearly resembling meteoric iron than that experimented on by Mr. Fairbairn. The Austrians are said to be using for their cannon an alloy called Aich metal, from the name of the inventor, and composed of copper 600 parts, zinc 382 parts, and iron 18 parts. Its tenacity and toughness are said to be very great.

Guns and Iron-cased Ships still attract the attention of engineers. A new form of rotating projectile, invented by Mr. Woolcombe, was described at the last meeting of the British Association. It is in form a thick zone or circular disc,—in fact, it is cheese-shaped, with the centre of gravity eccentric, or not coinciding with the centre of figure. It is fired from a smooth-bore gun, in which two equal and parallel segments of a cylinder have been inserted, to reduce the bore to the same sectional form as the shot. In consequence of the eccentricity of the centre of gravity, the shot rotates in its flight, in a plane parallel to its faces, and perpendicular to its axis, and this altogether independently of any rifling of the gun. Hence, on the principle exemplified in the gyroscope, the axis about which the shot revolves will remain parallel to its first position throughout its flight, and some of the causes of deviation in ordinary round shot are counteracted.

Renewed *experiments at Shoeburyness*, against a target of massive teak framing, with armour-plating resembling that of the *Warrior* and *Minotaur*, have shown that 4½-inch and 5½-inch wrought-iron plates can be easily penetrated by Mr. Whitworth's steel flat-ended shells, fired from a 120-pounder gun, with charges of from 23 lb. to 25 lb. of powder. The 275 lb. shot from the Horsfall 13-inch smooth-bore gun, with a charge of 75 lb. of powder, was also fired at this target, and smashed through armour-plate, backing, and skin, carrying completely away several superficial feet of the target. The Whitworth shells, on the other hand, made comparatively clean punched holes, which it would not be difficult to plug. The difference of result is mainly due to the difference in diameter of the projectiles, causing fracture with Mr. Whitworth's shells by punching, and with the Horsfall shot in a mode more analogous to cross-fracture. The difference of the charge of powder in the two cases must not, however, be overlooked.

Thus the balance of superiority, which for a short time had rested with the iron-clad vessels, is now undoubtedly reversed, and the guns are masters of the situation. In considering the influence of these experiments on the future of our navy, it must be borne in mind, that although it will probably be found to be impossible to clothe frigates of the *Warrior* type with a greater thickness of iron than has already been furnished and found vulnerable; yet, by reducing the height above water, the Americans have been enabled to use 7-inch armour-plates, and for the *Ericsson Monitors*, now building, it is said 10½-inch plates are being employed.

The question of the relative advantages and disadvantages of the Whitworth, Armstrong, and other guns, has not been advanced a single step by the recent trials, although it is now in a fair way for settlement. The remarkable results obtained by Mr. Whitworth are almost entirely due to the form and material of his projectile,—a form and material employed previously by others on a small scale, but with similar results.

Some remarkable investigations have been made by Mr. Froude, Professor Rankine, and Mr. Crossland, on *the motion of waves and the rolling of ships*. These are much too abstruse for quotation here, and indeed are, for the most part, of interest only to the scientific shipbuilder and mathematician. We may, however, mention an incidental result of Professor Rankine's, which possesses greater claims to popular notice. The height of waves is a subject on which savans and sailors have long had a dispute; the former affirming that, by actual measurement, they do not exceed twenty to thirty feet from trough to crest, at the maximum; the latter, who, from their long familiarity with the sea, should know of what they speak, maintaining that they constantly rise in storms to a height of a hundred feet, or more. M. Michelet not very long ago asserted, with warmth and sarcasm, that the off-hand scepticism of scientific men on this subject was in exceedingly bad taste, and that the sailors were, in his opinion, in the right. Professor Rankine, however, is able to justify his scepticism. He shows that, in a vessel floating on waves and rolling periodically in consequence of successive impulses, the *apparent direction* and force of gravity undergoes considerable changes. Hence the sensations of a passenger in such a vessel—whose body accompanies the vessel in her movements, and describes, like each particle of water, a circular orbit,—are really the same as if the force of gravity changed in that manner. Such a person judges of the height of the crest, and steepness of the wave front, not according to the real elevation and position of the crest, but according to its perpendicular distance from a plane which seems to be level, but which is really very far from horizontal. The sailor, in fact, measures the wave in a diagonal direction, which his sensations lead him erroneously to believe vertical. "This delusion seems to account," says Professor Rankine, "for the exaggerated descriptions which we hear, of waves 'mountains high,' and which present so strange a contrast to the results of accurate measurement. For example, the waves which Dr. Scoresby measured in the Atlantic Ocean, and found to be about thirty feet high, would seem, when estimated by the eye, under the circumstances just mentioned, to be upwards of ninety feet high, and of terrific steepness. The same delusive judgment as to the height of waves and the direction of gravity accounts also for the appearance, that many have observed, of enormous waves seeming to sink, and as it were melt away, just before reaching the ship." This is far from being the first time that science has shown the evidence of the senses to be a fallible guide.

Mr. Robert Aytoun has suggested *a new Safety-Break for railway trains* to the Scottish Society of Arts. He proposes to fix to the sleepers, between the rails, a longitudinal stringer of timber, five inches square, to be compressed by a pair of compound bladed springs, of any requisite amount of power affixed beneath the break-van, and under the command of the guard. The plan has some merits, but it is probable that the continuous breaks, already to some extent introduced, afford a readier mode of proportioning the break-power to the heavy trains now run upon railways, and they have the advantage of preventing shock, by distributing the retarding power to all the carriages.

MEDICINE, SURGERY, AND THERAPEUTICS.

MEDICINE.

Graham's Method of Dialysis in Cases of Poisoning.—This method of analysis, invented by the Master of the Mint, is becoming valuable as an aid in the investigation of the contents of the stomach, &c., in cases of poisoning. The chief difficulty, hitherto, has been, that the contents of the stomach are too viscid to pass through any filtering material, and, consequently, the separation of any poison is much impeded. Dialysis here comes in very usefully, and may be thus practised :—A round vessel of glass, open at the top and bottom, is taken : across the opening below is stretched, and firmly tied, a piece of De la Rue's parchment-paper; the vessel is then placed in a dish with sufficient distilled water to reach and cover the parchment; the substances to be dialysed are then introduced into the glass vessel and allowed to stand for twenty-four hours. The membrane will allow substances of crystalline form to pass, but retains those without definite shape, as gum, gelatine, albumen, &c. By this means, the crystalline alkaloids, morphia, strychnia, &c.; numerous metallic salts, as corrosive sublimate, arsenic, and so on, will be found, if originally present with the matters submitted to dialysis, in thin and clear solution, in the containing dish; when, of course, the tests for the identification of the suspected poison can be easily and satisfactorily applied.

Researches on Diabetes.—Dr. Pavy, professor of physiology in Guy's Hospital, has lately published a work on this obscure disease. According to Bernard, a French physiologist, the starchy matters that we take in our food, after being acted on by the saliva, become grape sugar, which is soluble, and is absorbed by the stomach, passing through the liver unchanged, to the lungs, where it meets with the oxygen of the air; a slow combustion then taking place, which aids in the production of animal heat. But by a well conducted series of experiments by Dr. Pavy, it is shown that grape-sugar, if present in the blood, invariably produces diabetes, not being burnt off, but passing out of the system by the kidneys. The following are his views :—Just as, in the vegetable economy, starch becomes sugar before it is carried over the system of the plant, and becomes again insoluble as lignin, or cellulose; so starch, in the animal digestive tract, after being acted on by the saliva (without which action starch is perfectly indigestible), becomes soluble sugar, preparatory to becoming insoluble again in the liver, as amyloïd matter, or insoluble liver-starch. The further destination of the amyloïd matter is not yet known; but it probably is changed into fat. This amyloïd matter is converted into grape-sugar only in disease, and as a result of death. The exact nature of the process by which amyloïd is converted into grape-sugar, in disease, is not precisely known; but some forms of nerve disturbance, and some chest affections, will act as exciting causes: so also will the eating of asparagus, of carrot, and dandelion. When this change is taking place, of course grape-sugar enters the blood, and passes off by the kidneys, the symptom called diabetes being produced. As regards treatment, Dr. Pavy recommends—not to refrain from drinking water, not to give acids as drinks. The food should consist of as much animal food (which is destitute of starch) as possible. Farinaceous and saccharine articles of diet to be most scrupulously avoided. By this means, the system being deprived of its principal source of sugar, the disease is held in check. Claret is the most suitable wine; dry sherry may also be drunk. Fat is suitable; and also cod-liver oil. A great desideratum in this complaint has been a kind of bread, so to speak, destitute of starch; the bran biscuits and gluten bread being very distasteful. Dr. Pavy has invented a very palatable substitute for bread, which is prepared under the name of almond food by a London baker, under Dr. Pavy's instructions; and which consists of eggs and blanched almonds, freed from sugar and gum, but retaining their oil.

SURGERY.

Removal of Portion of the Lower Jaw in a case of Fixed Closure.—A somewhat novel operation was performed by Mr. Christopher Heath, at the Westminster Hospital, London. The subject of it was a youth of fifteen, who for six years had been in the following distressing state.—The jaws were firmly closed on each other, the teeth of the upper jaw overlapping those of the lower: the only way in which food (and even then only soft, semi-fluid food) could be introduced into the mouth, was by coaxing it through a small aperture between two teeth on the right side. The boy was admitted on the 1st of July, in a most emaciated state; and on the 8th, chloroform having been administered, Mr. Heath removed a wedge-shaped piece of bone, by means of the saw, from the lower jaw on its right side, and consisting of its whole thickness. By this means a false joint was formed; and the operation succeeded so well, that when the boy was discharged in September (the wound being entirely closed), he was able to open his jaws to the certainly very useful extent of seven-eighths of an inch.

Oakum as a Substitute for Lint.—Dr. Sayres, surgeon to the Bellevue Hospital, in New York, states that for many years he has had a decided reference for picked oakum as a substitute for the much more expensive geon's lint. His recent ample experience as an operator confirms him s view. Lint, in fact, especially when composed of cotton, is rather an obturating (closing-up) than an absorbing agent, being wetted by the discharges from a wound only at the point of contact, its substance never being traversed; and thus the passage is obstructed rather than favoured. Picked oakum, on the contrary, becomes soon saturated, and keeps the surface of a wound clean and dry. It drains off the discharges like a syphon, rendering it necessary to place india-rubber sheeting or oiled muslin under the wound. When there is much inflammation, if the oakum be wetted in cold water, and the air excluded by wrapping a little oiled muslin round the part, a neat and comfortable poultice is secured. When a ball has traversed the parts through and through, a few fibres of oakum passed through by means of an eyed-probe will keep the wound fresh and clean. The insignificant price of oakum is another strong recommendation.*

Removal of Tumours from the Windpipe by the Aid of the Laryngoscope.—The Laryngoscope is an instrument, the honour of inventing which is claimed by some for Professor Czermak, by others for Signor Garcia, the celebrated singer. It consists essentially of a little square steel mirror, and a reflector. The mirror is pushed to the back of the throat above the opening of the windpipe, and light thrown on it from the reflector: the reflector itself being illuminated by a lamp. By this means, the interior of the larynx (*i.e.* the upper part of the windpipe) may be clearly seen reflected on the mirror. The subject of the above operation applied to Dr. Gibb, of Portman Square, for hoarseness and partial loss of voice, which had existed for twelve years, and had resisted every tried method of treatment. By the aid of the laryngoscope, Dr. Gibb discovered two small tumours, the size of peas, situated within the windpipe. These were removed; and the complaint that had existed for twelve years completely disappeared.

Astigmatism.—This is an affection of the eye, which has hitherto been considered rather a rarity, but which Professor Donders has lately shown to be not uncommon, occurring in about two out of every hundred that have been seen by him for weakness of sight. It consists in an unequal degree of curvature, on comparing two principal sections (meridians) of the cornea. The result is, that objects are seen further off in one meridian (say the vertical one) than in the other (the horizontal). In the case of the present Astronomer Royal, the furthest point of distinct vision in the erect meridian was three and a half inches, whilst in the transverse meridian it was five inches. As a consequence, points are seen as lines: whence the name, from *a*, without, and *stigma*, a point or mark. The following proceeding will make manifest the affection, if present:—A luminous point, as the sunlight streaming through a small hole in the closed shutters, is looked at; and between the eye and this point are passed in succession, a slightly convex and then a slightly concave lens. The point of light will alternately appear extended in two opposite directions, that is, vertically and horizontally: the direction of the line, under the use of convex glass, is the same as that of the meridian of greatest curvature; whilst the concave glass shows the direction of least curvature of the cornea. The remedy consists in the use of cylindrical glasses, made by dividing a glass cylinder parallel to its long axis. A glass prepared in this way exerts an influence on light falling on it in a plane perpendicular to its axis, whilst on light falling in a plane parallel to its axis it has no effect; so that the faulty diameter of the cornea is compensated for, and the correctly curved diameter is not interfered with.

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* "American Medical Times," vol. v. No. 6.

Transplantation of Teeth.—At the congress of German dentists, held in September, 1862, M. Süersen, of Berlin, stated that he considered Faulkner's orange vulcanized india-rubber as preferable to all other kinds: he had analysed it, and found it innocuous. When made up for the purpose of fitting in artificial teeth, it was necessary, he found, to subject it for an hour and a quarter to steam, heated under pressure to between 360° and 386° Fahrenheit. He also stated that transplantation of teeth had been practised by Mitscherlich of Berlin for the last eighteen months. His method was to implant into an empty tooth-socket, a human tooth that had been extracted some time previously. The tooth itself took no part in forming the union; but material was thrown out by the socket which firmly fixed the tooth in its place. The chief conditions of success were, that the individual should not be too old, should be in good general health, and the socket for the tooth should be sufficiently large. Mitscherlich had been successful in eight cases out of ten. M. Süerson himself, owing to want of good selection of teeth, not quite so fortunate.

THERAPEUTICS.

Nicotine as an Antidote to Tetanus.—In November, 1856, the Rev. Professor Haughton, of Trinity College, Dublin, read a paper in the Royal Irish Academy, in which he showed that in frogs poisoned by strychnia, the effect of the poison is counteracted by nicotine (the active principle of tobacco). The causes of tetanus are chiefly three; that form which arises from the irritation of certain kinds of wounds, conjoined probably with atmospheric influences; that form arising from no ascertainable cause (of course there *is* a cause, but it cannot as yet be traced), in which, however, there is generally a story of exposure to cold and wet; and, lastly, the form which results from the taking of strychnia. The first species is called Traumatic; the second, Idiopathic; the third, differing slightly in its symptoms from the other two, is Tetanus from strychnia. To resume; in 1858, Dr. T. O'Reilly, of St. Louis, Missouri, in a case in which six grains of strychnia had been swallowed (a poison so virulent, that half a grain is sufficient to destroy adult human life), brought the patient round again, by administering an infusion of dry tobacco leaves. Dr. Haughton has lately published a pamphlet on the subject, in which he gives the result of treatment by this method in four cases. The first case was traumatic, and the patient was dying when seen; but the effect of the nicotine was well marked, although life was not saved. The nicotine was given in one-drop doses: there was an immediate relaxation of the tetanic spasm in the muscles of the face, throat, and chest. The second case was idiopathic; there had been exposure to cold. The patient recovered entirely in eleven days; during which 44 drops, or 26·4 grains of nicotine, were taken by him. The effect of the nicotine was as follows:—There was an immediate relaxation of the muscles of the back, abdomen, and chest; a cessation of delirium; a slight increase in the number of pulsations at the wrist; profuse sweating—the perspiration having an intolerable odour of snuff; and a tendency to deep sleep. The third case was that of a boy who was treated in the Meath Hospital, by Dr. P. C. Smyly: the boy had taken four grains of strychnia; and in his case, emetics had been given with effect. An ounce of cut cavendish was put into a jug, and a pint of boiling water poured on cold water was then added, until the contents of the jug were tepid. This was taken at twice, and was followed by vomiting. Another pint made in the same way with another ounce of tobacco had the same effect. A third pint made from the same ounce was partly retained by the stomach: profuse sweating and sleep came on: in half an hour there was complete relaxation of the muscles, and the boy recovered rapidly. The fourth case was traumatic, coming on after a compound fracture (fracture with communicating wound) of the fore-arm. During four days, 54 drops of nicotine, equal to 32½ grains, were given; and recovery took place.

Tannin as an Antidote for Strychnia.—M. Kurzak, in the *Journal de Chimie Medicale*, concludes from his experiments, that if administered in time, tannin is an excellent antidote to this poison. Twenty or twenty-five times as much tannin (the active astringent principle in oak-galls, &c.), as the amount of strychnia taken, must be given; and it would be prudent to give it even in larger proportion. Infusion of galls, even of black tea (if but little strychnia has been taken), of acorns, chestnut-bark, willow-bark, oak and elm-bark, tormentilla-root, or of the root of the carnation, may any of them be given, as these substances are rich in tannin. A great recommendation to nicotine and tannin is, that both are easily obtained in almost every dwelling.

Sarracenia Purpurea in Small-pox.—This plant, the Indian cup, a native of Nova Scotia, has recently been much spoken of as a remedy for small-pox, the course of which it is said to shorten, and also to prevent entirely the disfiguring pitting which so often follows this disease. Dr. Manning, of York, however, states that he has given the Sarracenia Purpurea a good trial, and he finds that it has no effect at all, either in checking the course of small-pox, or in preventing pitting.

Formation of Cinchona Plantations.—The rapid destruction of whole forests of the cinchonas (from which Peruvian bark and quinine are obtained), for the purposes of trade, without corresponding restoration by means of the growth of fresh trees, has led to great fears that in time we should be totally deprived of this valuable tree. To prevent this, our Government has been forming plantations of cinchona on a large scale, which are situated on the Neilgherry hills. The total number of plants at present is 72,568. Of these, 13,700 are placed permanently out of doors; 18,076 are in the plantation nurseries; and 40,792 are small, and under glass. Extensive clearings are being made: the Denison and Markham plantations, both at Neddiwuttum, together contain 410 acres. Another plantation is being formed at Pyearrah, of 250 acres. In addition to this, private individuals are anxious to grow the cinchona, and have already bespoken 22,000 plants.

MISCELLANEOUS.

At the Pathological Society of London, last October, Mr. Canton showed a horn which he had removed from the upper eyelid of an old woman: it commenced as a wart four years ago, and had attained a considerable size.

The total number of in-patients admitted into the wards of all the London hospitals together, during 1861, amounted to 35,506,—a number surpassing the entire population of many a provincial town, and exceeding that of one English county. The whole number of in-patients in all the London hospitals on the night of the last census was 5,625.

M. Reviel has instituted a series of experiments at the Hôpital Lariboisière, Paris, and has shown the existence of a large amount of organic matter floating in the atmosphere. The dust of a ward was collected and found to contain 36 per cent. of organic matter, chiefly in the form of epithelial cells. In the air of rooms containing the sufferers from contagious inflammation of the eyeball, small corpuscles were detected analogous to those of the virus thrown off from an inflamed eye. It is probable that infection, therefore, is mechanically conveyed from eye to eye by means of the air.

In the course of one week, Dr. Letheby detected in the City of London no less than 4,525 lb. of meat and seventy-three head of game exposed for sale, but totally unfit for human food. This amount was made up of sixteen sheep, ten pigs, thirty-two quarters of beef, and about fifty joints of meat beside.

Dr. Ogilvie, of the Native General Hospital, Alexandria, lately removed from a Turk, a native of Adalia, in Asia Minor, a large tumour of the abdomen, the result of Arabian Elephantiasis. The weight of the tumour was forty-three pounds: the man made an excellent recovery.

Mr. Glaisher, in his recent scientific balloon ascent, found that as a rule the number of beats of the pulse was increased the higher he rose. At the height of 29,000 feet above the earth he became insensible; and it is interesting to note the order in which he lost the use of his powers. In the first place, he felt an inability to move his limbs; then to keep his head erect; then his body fell to the floor of the balloon-car. Suddenly an intense darkness came over his sight; still he could hear; his hearing then went, and lastly, his self-consciousness: he felt as if going to sleep. Through the presence of mind of Mr. Coxwell, his companion, who was, however, becoming temporarily paralysed himself, and who had to open the escape valve for the gas with his teeth (his hands failing him), both valuable lives were saved. During the ascent there was no evidence of either intense cold, or of embarrassment in breathing.

The loss of infant life in Sheffield (that is, in children from birth to five years of age) is one-half of the whole number of deaths.

MICROSCOPE.

Supposed Discovery of a Microscopic Vertebrate Jaw. — Dr. Wallich figured the "Annals," a minute object which he had found upon a slide containing mud, dredged off St. Helena. It was about the $\frac{1}{100}$th of an inch in length, and bore so remarkable a resemblance (as the writer can vouch from personal examination of it) to the lower jaw of some mammalian animal, that it has been a puzzle to naturalists, who have referred it—some to the mandible of a fish; others to the lingual ribbon of a *mitra*; others to the claw of a minute crustacean; and others yet again to the valve of a *pedicellaria* (or minute process found upon sea-urchins). After due consideration, no one now believes that it ever formed part of a vertebrate animal; but its interest as a pseudomorph (or imitator of another natural form) is undiminished. Mr. Spence Bate makes out a good case for its being the last joint of the leg of a small hyperine crustacean, of the genus *Phrosina*, which is very abundant in the tropical and subtropical Atlantic Ocean. Dr. Wallich himself inclines to favour the opinion of Mr. Busk, who shows the extremely close analogy between the object in question and certain Pedicellariæ.

Presence of Acari in Solutions.—The circumstance mentioned in the last number has received elucidation from a paper by Mr. Shadbolt to the Microscopical Society. The Acari found in these unusual situations appear to belong to a widely diffused species, which has been found adhering to the walls of a room in great numbers, whence they make their way into the solutions. The remarkable fact still remains, however, of their being found in strong nitrate of silver baths, which might be expected to be fatal to animal life. It is probable that the *Acarus Crossii*, at one time supposed to have been produced by the electrical experiments of Messrs. Crosse and Weeks, was of the same species.

Urticating Filaments in Mollusca.—Dr. Bergh, of Copenhagen, has shown that these minute organs exist not only in Hydra, the Actiniæ, and the Medusæ, but also in several Molluscs. He has demonstrated the existence of true urticating batteries of sacs filled with *cnida* (or nettling filaments) in the typical forms of Eolidæ, and in several other genera of naked-gilled Mollusca. They may be almost regarded as a family character. In every case they are planted at the extremities of the papillæ, above the hepatic lobe, in a sac opening to the exterior by an extremely minute pore at its summit. Although called urticating filaments, it is probable that they have not a true urticating function; for stinging is not always a concomitant of their presence, as in the case of these Eolids. The use of them must, therefore, be regarded as at present unknown.

New Method of preparing Algæ, &c.—Professor Reinicke recommends the following mixture as a dense, non-drying fluid, which prevents the shrinking of soft tissues; viz. alcohol (90°), 3 parts; water, 2 parts; glycerine, 1 part. The spirit, being lighter and more limpid than water, compensates for the greater density of the glycerine. The preparation being placed on the glass slide in a drop of water, another drop of the above mixture is added to it, and it is placed aside, secure from dust, to evaporate till nearly all the fluid is gone. A second drop is then added, and so on, until a sufficient quantity of the non-drying material is left to cover the object. The glass cover should not be put on until all the evaporable part is gone. In this way M. Reinicke has succeeded in retaining the natural *form*, *colour*, and structure of delicate filamentous algæ, fungi, and animalcules; and objects taken in the act of fission, conjugation, &c., remain unchanged, and as useful as living subjects.

MINERALOGY, METALLURGY, AND MINING.

MINERALOGY.

THE composition of *Meteorites* is a subject which is interesting, on the ground that they are generally supposed to have their origin independently of the Earth. We are always curious to obtain any information which shall throw light upon the constitution of the various members of the solar system: we wish to know whether the other worlds are like our own. With the exception of the recently discovered spectrum analysis, we have few means of obtaining such information beyond the examination of fragments, such as meteorites, which have strayed out of their course, and come under the influence of the Earth's attraction. Here, if anywhere, we may expect to find elementary substances not to be found in terrestrial nature. So far, however, no such discovery has been made; the same elements, and frequently the same compounds, are found in these strange visitors, as those with which we are already familiar. On the 1st May, 1860, a meteoric stone fell at Guernsey, Ohio; which was subsequently examined by Dr. J. Lawrence Smith, Professor of Chemistry in the University of Louisville, Kentucky. He states that there were three or four explosions, like the firing of cannon, at intervals of a second or two, then sounds like musketry, and finally a rumbling. Above thirty stones fell, the largest weighing 103 lb. All the stones had a black coating, 1-30th to 1-40th of an inch in thickness. On being broken, they showed a grey mass, with particles of nickeliferous iron. Ten minutes after the fall they felt as warm as if they had been lying in the sun; and he concludes that their temperature on falling must have been short of redness, and may have been less than 200°. On analysis they furnished 11 per cent. of nickeliferous iron, and 89 per cent. of earthy matter. The latter he concluded to be in the main a mixture of olivine and pyroxene. His conclusions regarding meteorites he sums up thus:—1. The light emitted by meteorites is not from their incandescence, but from electricity or some other cause. 2. The noise they produce is not from the explosion of a solid, but from their rapid motion, or in part from electrical discharge. 3. Meteoric showers do not result from the rupture of one mass, but from a separation of distinct meteorites, which have entered the atmosphere in groups. 4. Their black coating is already formed when they enter the atmosphere.

A meteoric stone fell at Chassigny, near Langres, in October, 1815, and was described by Vauquelin. It has been lately re-examined by Mr. A. Damour, who was led to notice the similarity in its composition to one of the species of the mineral peridot. [Peridot, or chrysolite, is the name given to the paler and more transparent crystals of olivine.] His own analysis confirmed this supposition. The stone differs from the majority of meteorites by its pale yellow colour. It contains neither nickel nor iron in the metallic state; and it is not magnetic, with the exception of a thin black crust covering it. This seems to indicate, that during its incandescence, the protoxide of iron which it contained became converted into black or magnetic oxide. On analysis, the substance of the stone furnished 35 per cent. of silica, 32 of magnesia, and 27 of protoxide of iron; agreeing in composition with the ferruginous variety of peridot, called Hyalosiderite. [This mineral is found in a brown basaltic rock at the Kaiserstuhl, in the Breisgau.] Several mineralogists have established two chief classes of meteoric stones:—1. Those containing alumina, and which may be considered as belonging to the Felspar family. 2. Those containing no alumina, but more or less of magnesia, oxide of iron, lime, &c., most probably in the form of pyroxene and magnesian silicates. Mr. Damour would place the Chassigny stone in the second of these classes.

Effects of heat on Felspar.—M. des Cloizeaux has examined the molecular changes produced in certain minerals by the action of heat. By means of a polarizing microscope he could detect any alteration in the relative directions of their optic axes. Many crystals have the property called "double refraction;" that is, they split up a ray of light passing through them into two parts. But there is one direction in each crystal, sometimes two, as in felspar, in which there is no double refraction; these directions are called the optic axes of the crystal. In a small plate of orthose (or common felspar, so often found in granite and other rocks), the optic axes separated the more, the higher the temperature was raised. On cooling again, they returned to their original condition; showing, therefore, no *permanent* modification. He found, however, that if the substance were heated for thirty-six hours to a dull red, or for fifteen minutes to a white heat, a permanent change was effected. His experiments have led him to conclusions contrary to the hypothesis which admits the necessity of an excessive temperature to explain the formation of crystalline rocks where orthose and quartz predominate; and he has found the same thing to hold with other varieties of felspar. On the other hand, several varieties of the same mineral show neither temporary nor permanent modification under the influence of heat; and he infers that they have not been subjected in nature to the same influences as those previously referred to.

Esmarkite was the name given by Erdmann to a mineral found at Brakke, in Norway. M. Pisani has shown, however, that the name has in reality been given to two species of Norwegian minerals which are distinct; and he recommends, therefore, that the name be suppressed altogether.

Mineral Wealth of Australia.—The *Melbourne Argus* has recently given a series of letters from a correspondent deputed to examine the mineral resources of Australia. His reports are particularly cheering. They show that even in their oldest gold-fields, mining is yet in its infancy. Alluvial fields are still unexhausted, and auriferous quartz reefs without number lie untouched in every district for want of capital and labour.

The correspondent also draws attention to mines of antimony, silver, and iron; of which little or nothing was before popularly known.

Gold in Wales.—During the past quarter, mining periodicals have been thickly strewn with reports, generally very sanguine, of the progress of gold mining in the principality; with analyses of the quartz, and latterly with prospectuses of companies and their usual accompaniments. No further agitation is required to bring the subject under the notice of the mining or share-dealing public.

Mr. Readwin, the pioneer of this enterprise, read a very interesting paper on the subject before the British Association, to which we refer our readers.

METALLURGY.

In these days of armour-plates and monster cannons, the manufacture of *iron* holds the first place in metallurgical interest. The magnitude with which iron smelting is conducted may be judged of by the following items, taken from Truran's new work on the iron manufacture of Great Britain. At Dowlais, the weekly make of iron is about 130 tons, and the ordinary weekly amount of slag, 250 tons. The materials delivered weekly at the top of the furnaces would occupy 1,066 cubic yards. The air delivered in the same time by the tuyeres (*i.e.* the nozzles of the blast apparatus) weighs 1,695 tons and measures 50,550,400 cubic feet. Each ton of iron is reduced by 43·5 cwt. of carbon, and 388,800 cubic feet, or 13 tons of air. The weight of air is to the weight of material added at the top, as sixteen to seven. For each ton of liquid matter obtained (that is, including both iron and slag), no less than 129 cwt. of gases are evolved from the furnace.

Puddling by Machinery.—In the conversion of cast-iron into malleable iron by the process of puddling, the most intense bodily labour is involved; whilst the workmen are exposed to an overpowering heat. It is, therefore, satisfactory to find that machinery has been introduced into the process—an invention having been patented by MM. Dumey and Lemut, of St. Dizier, France, through a London agent.

Effect of Wolfram on Steel.—A series of experiments have been carried out by direction of the French minister of war, to ascertain the effect of the addition of wolfram to bronze, wrought-iron, and steel. The report states that there is no advantage to be got by adding it to bronze, and probably little in the case of wrought iron; but that wolfram may safely be recommended to give to steel qualities which increase its value considerably. It concludes by saying that the small addition which would ensue in the price of the steel would be far more than counterbalanced by the advantages obtained.

MINING.

There is considerable interest in examining the traces which are left to us of mining as practised by our predecessors in ancient times. It has often been found that the materials thrown aside as useless by miners and smelters in former times turn out on examination to be exceedingly rich in metal. Professor Ansted reports the discovery in the Mendip Hills, about three miles from Wells, Somersetshire, of a deposit of lead, producing *débris* of old mines and lead washings of ancient miners, filling up the bed of a stream that flowed in former ages. This metallic slime of exceeding richness amounts, he says, to 600,000 tons, extends over 25 acres to the depth of 30 feet, and is computed to be worth half a million sterling.

Early British Tin-Works.—Mr. Hunt remarks that there is little doubt that tin was procured from the rocks, and collected by washing from the streams of Cornwall and Devonshire, long before the invasion of Britain by the Romans. He thinks it probable that the bronzes which decorated the palaces of the kings of Babylon and Nineveh were manufactured of British tin.

In a paper on the Remains of Early British Tin-Works, read at a meeting of the Cambrian Archæological Association in the beginning of September last, Dr. Barham states, that the evidences of very ancient tin-workings are still to be found in many parts of Cornwall and Devonshire. In St. Just, near Cape Cornwall, there are rude workings which are probably early British. In other places there are excavations showing that remarkable want of engineering knowledge which distinguishes all early workings. Many of the old workings belong without doubt to the Roman period, and there is evidence that the educated skill of the Romans was brought to bear upon their Cornish tin mines. They even executed a large *arched stone level*, very different from any other of the "old men's workings." The description agrees with that of Roman works in Spain.

Lead.—In the International Exhibition was a pig of lead of the Roman period, as well as two photographs of an ancient mine in the Shelve district, Shropshire.

Iron.—During the summer of the last and present years, explorations have been made in the Cheviot district, resulting in the discovery of a walled town, several fortlets, scattered hut circles, and tumuli of the Celtic period. The discovery of pieces of iron slag gives a new view of Celtic life, as a general impression prevailed among antiquarians, that the ancient Britons were not acquainted with the art of smelting.

Electric Lamp.—Few improvements have been made in the safety-lamp since the time of Davy and Stephenson. Its safety lies rather in the warning it gives of the presence of gas, than in allowing the miner to work in a dangerous atmosphere. No miner should remain in a place which his lamp shows him to contain an explosive mixture of gases. MM. Dumas and Benoit have invented an apparatus for lighting miners, the source of illumination being induced electricity. Their apparatus consists of three parts —(1) an element of a pile; (2) a Ruhmkorff's coil; and (3) one of

Geysler's glass tubes ;—the whole so disposed as to furnish a light sufficient for working, even where other lamps go out. [It is quite certain that where lamps go out the atmosphere is unfit for breathing ; nevertheless, it might be necessary to explore it temporarily.] The light produced does not heat the tube, and is inaccessible to the gas; there is consequently no danger of firing the explosive mixture outside. The whole apparatus is perfectly isolated ; it is as solid as the lamps now used ; gives off no noxious vapour, and may be relighted at any moment. It can act for at least twelve consecutive hours without diminution of light.

PHOTOGRAPHY.

HER MAJESTY has been graciously pleased to authorize the presentation to each member of the London Photographic Society of a copy of the excellent photographic portrait of the late Prince Consort, taken by Mr. Vernon Heath. The Council have already taken steps to avail themselves of the privilege granted by the Queen, and will shortly be in a position to issue the requisite number of prints, which will be distributed to all subscribers for the current year.

A faithful *carte de visite* portrait of Mr. Hardwich has, to the extent of one hundred copies, been distributed, by Mr. St. George, amongst the members of the North London Photographic Society.

As evidence of the appreciation of Photography, as a branch of the Fine Arts, it is satisfactory to notice the recent announcement of the Glasgow Art-Union. It has this year been decided to issue to the subscribers, instead of the usual guinea engraving, three large photographic reproductions from original paintings. The subjects respectively are—"The Better Land," by G. J. Sant, A.R.A. ; "The White Cockade," by J. E. Millais, A.R.A. ; and an illustration from Tennyson's "Morte d'Arthur," by Noel Paton, R.S.A. The original paintings are intended for distribution, as prizes, and the reproductions, by Mr. Annan, of Glasgow, are in themselves first-rate examples of photographic art.

The opinion we ventured to express in our last with regard to the causes of fading so lamentably manifest in the Gallery of Photographs lately forming part of the International Exhibition, has received a signal confirmation from a specimen in the possession of Dr. Diamond, to which Mr. Malone took an opportunity of referring at a recent meeting of the London Photographic Society. The print in question was covered with the usual pasteboard mount and glass in front ; and although for several months it had been freely exposed to the light, had not suffered any apparent deterioration. On removing the print from its frame it was found, however, to be very much faded in those parts which were obscured by the mounting-card, so that the oval figure of the latter was clearly discernible upon the face of the print ; and thus it appeared that exposure to the light and warmth of the sun had been directly instrumental in preserving the photograph from change, no doubt by aiding the evaporation of the hygroscopic moisture from the central portion of the picture, and there maintaining a drier condition of surface than was possible in other parts which were never brought under the protecting influence of sunlight. An observation which points to the same conclusion, is the greater degree of permanence manifested by such prints as are freely exposed to air and light in shop-windows, as compared with the condition of others kept for stock in portfolios. The exceptions to this rule of general experience are rare, and appear to be such instances only as are obviously favoured by the maintenance of a high temperature or unusually dry atmosphere in their vicinity, and where, consequently, the proportion of hygroscopic moisture absorbed by the prints, their paper mounts, and adhesive backing, is reduced to a minimum.

The composition of the photographic image has again been brought prominently into notice by the lecture delivered by Mr. Malone on the occasion already alluded to (December 2nd, 1862). The experimental facts urged in favour of the truly metallic nature of the darkened particles which constitute the shadows of the picture, were based upon the result of exposing to sunlight a solution of ammonio-nitrate of silver, which had by repeated use become contaminated with sundry organic matters derived from the paper. The product was very similar to that before obtained by Mr. Spiller in working upon chloride of silver in an extremely fine state of division; there was no doubt that the dark grey particles were composed entirely of metallic silver, since they imitated all the reactions of this elementary substance, and remained insoluble and unaffected by the several chemical agents usually employed in the process of fixing the photographic image.

The Council of the London Photographic Society have decided on giving prize medals at the next exhibition of the Society. It is believed that four silver medals will be awarded: one for the best landscape; one for the best portrait; one for the best example of photographic art, whether a composition, picture, or copy of a work of art; also, for discovery or excellence of manipulation. The exhibition will probably be held at the Suffolk Street Gallery early in 1863.

The Marseilles Photographic Society have appointed a commission to inquire into the practical value of a suggestion made by M. Megnier, to employ the sulpho-cyanide of ammonium as a fixing agent in photography. The aqueous solution of this salt is said to dissolve the chloride and iodide of silver as freely as does hyposulphate of soda, at the same time not being liable to permit the formation of the black sulphide of silver on standing at rest, or by contact with the free nitrate on the surface of the print.

A proposition of great importance has, during the past three months, occupied a large share of attention on the part of practical photographers. It has reference to the use of certain gum-resins for the purpose of imparting to paper a close texture and lustrous surface, which qualities have hitherto been secured only by the use of albumen. Our most eminent photographic artists have long agreed in condemning the use of albumenized paper, as being altogether unsuited to the representation of many subjects, on account of the excessive and often objectionable glaze apparent on such prints; its employment seemed however, virtually, a necessity, from the difficulty of rendering by other means the details in shadow. The all but universal employment of albumenized paper appears likely to suffer a severe check by the introduction of the resinized surfaces of Mr. Cooper. Several formulæ have been announced in which as many different gum-resins have been selected to fulfil the object in view. It is scarcely probable that the details of the new process should already be incapable of improvement. Gum benzoin was first used, but the recommendation at present is in favour of the employment of a mixture of frankincense and Chio turpentine—one ounce of the former and one drachm of the latter being dissolved in half a pint, or rather less, of methylated spirits of wine, with the addition of two drachms either of the chloride of cadmium or zinc, to furnish the necessary element for the formation of chloride of silver. The resin-paper is prepared merely by immersing in this alcoholic solution for about five minutes the papier Saxe or Rives, gradually lifting and removing the sheets, draining, and drying rapidly before a fire; they are made sensitive by floating on a solution of nitrate of silver (sixty grains or upwards to the ounce of water), and when dry are ready for the printing-frame. It is necessary to print deeply in order to allow for a considerable loss of vigour always experienced in the after processes of fixing and washing. The specimens which have been exhibited as the results of this process justify the hope that we shall shortly be placed in possession of a system of photography by which more artistic effects may be produced with greater ultimate security upon the score of permanence.

We may judge of the commercial success which has attended the operations of the Contractors for Photography at the International Exhibition, by the announcement made by Mr. England in reference to the quantities of paper and chemicals used during the busy period of six months that the Exhibition building has continued open to the public. The sale of photographs is not likely, however, to be restricted to the *quarter of a million* stereoscopic slides already disposed of. The materials used amount in round numbers to the following:—

White of egg	200 gallons.
Paper	[illegible] reams.
Nitrate of silver	2,500 ounces.
Metallic gold	[illegible] ounces.
Hyposulphite of soda	[illegible] cwt.

Among the novelties in apparatus may be mentioned the beautifully moulded glass dishes of Messrs. Chance, intended specially to hold the nitrate of silver, a corrosive agent which the ordinary glaze upon earthenware is not well able to withstand. The "Patent Ebonite" baths and other apparatus manufactured by Messrs. Silver and Company, are, on account of their lightness and portability, exceedingly well adapted to the wants of the photographic tourist. They are made of India-rubber hardened by exposure to a higher temperature than that usually employed in the process of vulcanization; the material is consequently unaffected by boiling water, and although sufficiently elastic, is yet firm and rigid. It can be moulded almost to any shape, takes a beautiful polish, and is so light that an ebonite bath complete, with dipper, draining cover, and bung-screws, weighs considerably less than the silver solution contained in it. A stoppered bottle, made to hold a pint of water, weighs when empty but four ounces, a mere fraction when compared with its weight when filled. The shallow dishes or trays, developing cups, funnels, and other smaller requisites, may likewise be procured of this material, all of which are proportionately light and compact.

A very perfect description of prepared silk for covering the windows of the dark room has recently been introduced by Mr. Smartt. It consists apparently of two layers of oiled silk, with a deep orange, almost scarlet, pigment laid between; it is uniform in colour, and very durable. The material is made in pieces measuring three feet by eighteen inches, and a single thickness is sufficient to cut off all the chemically active rays of sunlight.

It is well known in London, that for five shillings may be purchased very beautiful reduced photographic copies of Rosa Bonheur's "Horse Fair," and Holman Hunt's "Light of the World;" the original engravings, by Mr. Thomas Landseer and Mr. Simmonds respectively, costing as much as ten guineas. The copyright of these works of art being held by Mr. Gambert, of Pall Mall, that gentleman has thought proper to take law proceedings, in order to protect himself against the piratical imitation, by means of photography, of these and other engravings published by him. The question of copyright has therefore been repeatedly discussed in the course of the arguments advanced by the plaintiff and defendants in these actions. It cannot, however, be said to be well defined, when it has been found necessary to refer back to Acts of George III., so long before the invention of photography, and when the words "fac-simile" and "main design" were intended to apply to copies or reproductions of the same size and style, and to such works as would be likely to deceive the purchaser at the time of making his bargain. It is clear, then, that a special Act must be obtained of more general application in these cases, and that the copyright of an engraving must forbid alike the reproductions of photography, as well as all other attempts by older processes of imitative art.

PHYSICS.

LIGHT, HEAT, AND ELECTRICITY.

SEVERAL papers have been published since our last number, somewhat modifying our views of the supposed rigidly definite character of spectrum analysis. M. Plücker, in a letter in the "Cosmos," shows:—1st. That the spectra of gases and vapours vary with the power of the induction coil, and show a tendency to continuity by spreading of the rays. 2nd. That this variability and spreading are caused by rise of temperature, so that the number and kind of the rays are dependent upon the temperature to which the gases are subjected in the capillary tubes. And 3rd. That by simultaneously increasing the density and temperature of highly rarified gases, there may be made to appear and disappear the various rays which constitute their spectra—alternated, separated, and reunited by the power of the heat. He has operated upon oxygen, nitrogen, chlorine, &c.; and in a second letter gives additional details, and states that glass tubes open at both ends may be employed instead of the usual ones, which are hermetically sealed.

Mr. J. H. Gladstone, F.R.S., has published in the "Philosophical Magazine" a paper "On the Violet Flame of many Chlorides." He says it is popularly known, that if common table-salt be thrown on red-hot coals, it produces violet flames, whilst by the ordinary method of examining bodies by prismatic spectrum analysis, it is well known that that substance gives rise to the yellow double line D.

Many other chlorides, for instance, the chlorides of copper, potassium, barium, platinum, gold, mercury, &c., also give the same violet light when sufficiently heated, but not the chlorides of calcium, lead, or magnesium, and these flames, when analysed, are found to consist not of the yellow light, but of *three* groups of lines; the first green, the second bluish-green and blue, and the third violet. To obtain the violet with chloride of barium, the heat must be much more intense. He concludes that the violet light of these substances is not due to the chlorine combining with the hydrogen or the carbon of the combustible, nor produced by the chlorine when it is decomposed by heat; and that the origin of the violet light requires further elucidation.

Alexander Mitscherlich, in a recent number of Poggendorff's "Annalen," has shown that the prismatic spectra of the flames of certain compounds of the metals are different from those of the metals themselves. He gives drawings of the spectra obtained from four different chlorides and one iodide, and shows the bearing of his observations upon solar chemistry and other questions.

Dr. Robinson has published in the "Proceedings of the Royal Society" an abstract of a paper "On the Spectra of Electric Light, as modified by the nature of the Electrodes and the Media of Discharge." He expresses his belief that spectrum analysis is not that invariable or absolute test of the presence of certain substances as is generally supposed. He made numerous experiments, in which the media of discharge were air, nitrogen, oxygen, hydrogen, and carbonic oxide, including in some instances the vapours of mercury, phosphorus, and bisulphide of carbon: he employed as electrodes, graphite, and twenty-three different metals: and obtained 185 *different* spectra, which he examined and measured. His conclusions are:—1st. That many lines are found in *all the gases*, and in many, *perhaps all* the metals: the existence of *such* lines must therefore be independent of the chemical nature of the substance. 2nd. That on varying the density of the gases, the spectra were found to vary, showing that the character and even the existence of certain lines are dependent upon the mere density of the medium, whilst the chemical conditions remain unchanged so far as the presence of the given substance is concerned. 3rd. That in the case of the presence of more than one substance, the spectra of the substances present are not merely superimposed without change, as has been generally believed: and that there is even reason to believe, that for certain lines, the action of different bodies upon each other may be antagonistic. And 4th. That the brilliancy of the lines is very little increased by greatly increasing the heating power of the electric discharge. If these results are confirmed by other investigators, we shall have to be much more careful in employing spectrum observations for the purpose of chemical analysis, and to learn what conditions modify the appearance of the lines before we can safely use them for that purpose.

MM. Wolf and Diacon, in a paper published in the *Revue de Sociétés Savantes*, have described a method they employ in spectrum analysis. They volatilize the substance to be examined by heat in a current of hydrogen, and ignite the escaping jet of hydrogen in contact with a jet of pure oxygen, and state that under these conditions many metallic chlorides, but especially alkaline metals and their volatile compounds, produce perfectly distinct and very lasting spectra.

Sir David Brewster, in a paper "On the Action of various coloured Bodies on the Spectrum," in the "Philosophical Magazine," Dec. 1862, has published his observations on the action of numerous solids, liquids, and gases on the solar spectrum. The substances employed include solutions of alkanet-root, cochineal, chica, cudbear, sulphate of indigo, sulphate of chromium, nitrate of cobalt, litmus, sulphate of copper, sulphate of ammonia and chromium, chromate of ammonia, sulphate of cobalt mixed with chromate of ammonia, sulphate of potash and nickel, carbazotate of potash, ferriocyanide of potassium, sulphate of potash and copper, bivanadiate of ammonia, chloride of iridium and potassium, carbazotic acid, ammoniuret of nickel, nitrate of copper, nitrate of nickel, ammoniuret of copper, chloride of copper, sulphate and nitrate of iron, chromate of potash, oxalate of chromium and potash, and arsenite of copper dissolved in hydrochloric acid.

In a paper communicated to the British Association, J. H. Gladstone, Esq., F.R.S., calls the attention of scientific men to those lines of the solar spectrum which are due to the terrestrial atmosphere, and incites observers to watch those lines and bands under every possible variation of circumstances, such as at different periods of the day and year, at different altitudes, &c. &c. By the aid of a portable spectroscope, he has made numerous observations of the kind, and has observed several bands not recorded in the map of Sir David Brewster and himself in the "Philosophical Transactions," 1860.

Dr. A. Weiss has been making spectrum observations in Greece: he succeeded in observing, in a surprising manner, a condensation of the lines of the red and yellow portions of the spectrum, and considers that, from the purity of the sky, Greece (and especially the Ionian Islands) is very suitable for spectrum observations.

M. Brachet has proposed as an improvement, in applying the electric light, to inclose the light within a globe of uranium glass, and that again within a second glass globe, of such a colour as to correct the greenish tone of the resulting light; and the proposal has been referred to MM. Regnault and Babinet for consideration.

The "motion of camphor towards light" has been the subject of a recent investigation by Mr. C. Tomlinson. He shows, by various experiments, that the crystalline deposits of camphor in bottles, which occur when that substance is exposed to the sun's rays, are not due, as has long been supposed, to the agency of light, but are simply and purely a result of unequal heat, the crystals always forming upon the coldest side of the bottle. · He has done the cause of science a service by correcting statements upon the subject which have been made in nearly all our leading chemical works.

Principal J. D. Forbes has published an elaborate paper in the "Transactions of the Royal Society of Edinburgh," "On the Conduction of Heat in Bars, and the Conducting Power of Wrought-Iron," and has observed that the order of arrangement of the "conductors of heat differs but little from their order of conduction for electricity," and thus confirms the results previously obtained by Wiedmann and Franz; also that "the diminished conducting power of iron, by increased temperature, harmonizes with similar facts in electricity."

M. Reitlanger has communicated a memoir to the Academy of Sciences at Vienna, "On the Sounds and Motion which take place within the Voltaic Arc." He employed Trevelyan's apparatus, driven by a voltaic current according to Mr. Page's process; and in some of the experiments the apparatus was placed in an exhausted receiver. He concludes that the sounds emitted by the above apparatus, as well as the motion of the revolving globes of Mr. Gore, are simply mechanical results of the electric discharge between the various movable metallic parts of the apparatus, where they are in imperfect contact with each other, and result especially from the tearing action.

Some interesting details respecting a discharge of lightning down a poplar tree are given in *L'Institut*. The lightning produced a groove like the furrow of a ploughshare, which did not proceed in a vertical line, but followed a spiral direction down the tree. It is interesting to notice this direction of action, as in another instance, at Birmingham, on the occasion of the Queen's visit to that place, lightning struck a pole fixed upon the Town Hall, and the direction taken by the electricity was also in that case in the form of a spiral down the pole.

ZOOLOGY.

M. du Chaillu and the Gorillas.—The long-vexed question of the authenticity of M. du Chaillu's travels in Equatorial Africa has received fresh light from Mr. W. Winwood Reade, who writing from Loanda, September 7, says :—

"Having spent five active months in the gorilla country, I am in a position to state that M. du Chaillu has shot neither leopards, buffalos, nor gorillas; that the gorilla does not beat his breast like a drum; that the kulu-kamba does not utter the cry of *Kooloo*, or anything like it; that the young gorilla, in captivity, is not savage; and that while M. du Chaillu affects to have been a *poor fever-stricken wretch* at Camma (June 1, 1859), he was really residing, in robust health, at the Gaboon."

Mr. Reade admits that—

"From the same source which afforded me proofs of his (Du Chaillu's) impostures, I learn that he is a good marksman; possessed of no common courage and endurance; that he has suffered many privations and misfortunes of which he has said nothing; that his character, as a trader, has been unjustly blemished; that his labours, as a naturalist, have been very remarkable; and that, during his residence in Africa, he won the affection of the natives and the esteem of those who most merit to be esteemed—the missionaries."

M. du Chaillu, not content with these concessions, in a letter to the *Times*, endeavours, from Mr. Reade's letter, to make it appear that the charges of misrepresentation still retained against him are groundless; and concludes by proposing that Dr. Gray and his friends shall deposit £2,000 on the one side, while he, on his part, will deposit £1,000; and, this being done, he will repair to the gorilla country, and if he succeeded in two years in bringing home eight perfect skins of gorillas, preserved with a preparation to be supplied by Dr. Gray, he would then claim the £2,000 in payment of his expenses; while, on the other hand, in case of failure, he would forfeit his £1,000.*

Habits of the Gorilla.—So much has been asserted of a marvellous character concerning these extraordinary animals, that we are glad to receive reliable information of a less romantic kind. Mr. Reade represents him as dwelling only in the densest parts of the forest, and feeding exclusively on vegetable matter, so that one kind of grass is always a sure indication of his proximity. At noon and eve he approaches the village plantations in search of plantains, occasionally uttering a wild cry, but which in rage becomes a sharp bark. By day he moves along the ground on all-fours, sometimes ascending trees; and by night he selects a large tree as his sleeping-place. He is exceedingly wary and keen of scent. The female, when about to produce young, builds a nest of rude layers of dry sticks and small branches torn off from the trees by the hand. When wounded, or missed, as a rule they will charge on all-fours; but the natives, being as nimble as apes, often escape. In the case of a man who had his hand crippled by the bite of a gorilla, the animal seized the wrist with his hind foot, and dragged the hand into his mouth as he would have done a bunch of plantains. Only traditional accounts exist of the gorilla having killed a man; and it is less feared than the leopard.

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* This proposed wager, on the part of M. du Chaillu, is treated as a joke by the *Athenæum* (December 6); a contributor to which journal says that an African trader would supply the five or six specimens in two years for £100. We have no desire to defend M. du Chaillu's *illuminations*, but we certainly think it would have been more satisfactory if Mr. Reade had given us the *grounds* on which he stated that M. du Chaillu had never shot gorillas, &c. To us, it seems very much as though Mr. Reade had felt bound to write *something*, and had *done* it.—Ed.

The Gorilla in Liverpool.—So celebrated has this ape become, that the acquisition of a good specimen is an important event to a museum. The Free Public Museum of Liverpool has just acquired a specimen, superior, perhaps, to any in this country in size and excellence of preservation. An account of the arrival of this skin (which was presented to the museum by Mr. Duckworth) will be found in vol. i. p. 537. The same museum is particularly rich in illustrations of this animal, and possesses the largest gorilla-skeleton in Europe.

It has been very currently reported that a young living gorilla has been exhibited at Liverpool. This, however, is an error; the animal in question being only a chimpanzee. The only living gorilla which was ever imported into this country was in the possession of Mrs. Wombwell in 1855–56, and was examined by Mr. Moore, the curator of the Liverpool Museum. It was very docile and active, and is now in the possession of Mr. Waterton, forming one of the remarkable features of that gentleman's museum at Walton Hall, where it has been seen and examined by the writer.

The Unicorn.—The controversy concerning the existence of this animal still continues. The distinguished naturalist, Rüppell, received accounts many years back which inclined him to believe that some such animal existed in the deserts lying south of Kordofan. The zoological objection to the possibility of the existence of an animal with a single (true) horn on the middle of the forehead, is, that no such horn can grow upon a suture of the skull. It is believed, however, by some authorities that the male giraffe possesses a third horn, growing from the very centre of the frontal suture.

The New British Snake.—The newly-discovered Coronella has again been taken in the New Forest, whence a female specimen was obtained and taken to Mr. F. Buckland. While in his possession it produced six young, two of which were drowned in the water placed in the cage; the remainder appeared to be well cared for by the parent snake. It is thus proved that this reptile is, like the adder, viviparous.

The King Crab (*Limulus polyphemus*) *found at Dover.*—This remarkable animal, the nearest living representative of the ancient trilobite, has lately been imported in some numbers into Liverpool, alive; and also into London. One was taken to the Jardin des Plantes at Paris, for presentation to one of the professors; but, for some reason, it was not presented, and, returning to England, it was thrown overboard in the Straits of Dover. Soon afterwards a person presented himself at the British Museum, and offered a living specimen for sale, asking for it £5, and averring that it had been taken at Dover. Could it be that it was the same individual that was thrown overboard in the Straits? At all events, it should be borne in mind that if found in future it is a naturalized, and not an indigenous, animal on our coast.

Discovery of Aquatic Hymenopterous Insects.—Mr. Lubbock, F.R.S., exhibited, at the Entomological Society, two species of aquatic hymenopterous insects, one of which swims with its wings. They were found in a basin of water obtained from a pond. While examining the Entomostraca swimming about in it, he was struck with astonishment at observing a small, veritable, *clear-winged* insect swimming with an easy, graceful, jerking movement, by means of its wings. Although some of the hymenoptera had been observed to descend temporarily into the water, this was the first which had been met with which was truly aquatic. He proposed to call it *Polynema natans*, and remarked that, in a palæontological point of view, it was worthy of notice that, had it been found fossil, there would have been nothing to indicate that it was not a terrestrial or aërial animal.

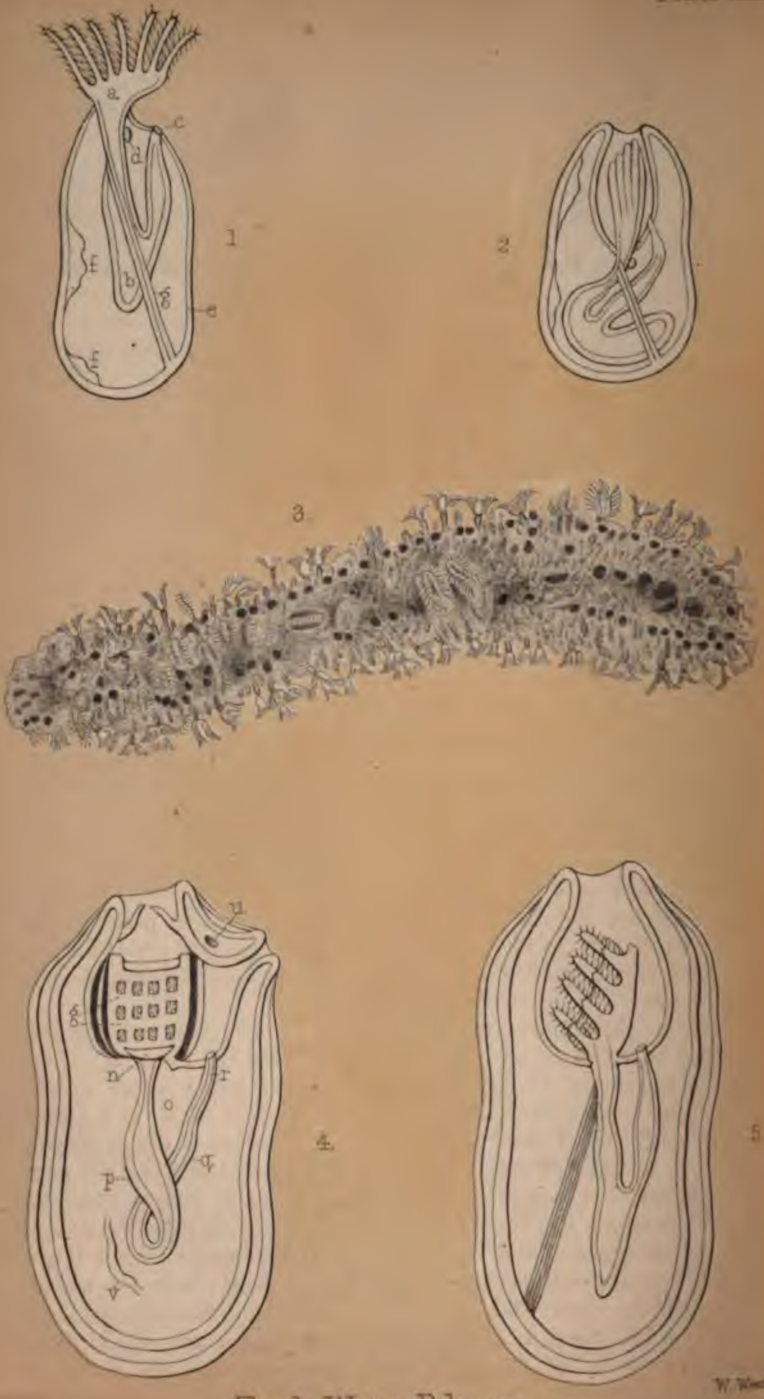
Cultivation of Oysters.—M. Coste has communicated to the Academy of Sciences an account of the progress of his oyster-beds on the west coast of France. That waves and currents carry the ova of oysters is a well-known fact, since the walls of newly-erected sluices are often covered with them; but in the island of Ré, where the inhabitants have for some years been engaged in cleansing the muddy sediment from their coast, the oysters are now permanently established. Seventy-two millions of oysters, from one to four years old, is the lowest average registered per annum by the local administration, representing a value of about two millions of francs (£80,000).

Iron-banks built by Animalcules.—M. de Watteville announces, in the *Journal de l'Instruction Publique*, that in the lakes of Sweden there are vast layers or banks of iron, exclusively built up by animalcules. This iron is called lake ore, and distinguished, according to its form, into gunpowder, pearl, money, or cake ore. In winter, the Swedish peasant, who has but little to do at that season, makes holes in the ice of a lake, and probes for an iron-bank; then, letting down a sieve, the loose ore is shovelled into it with a ladle, mixed, of course, with sand, which is got rid of by washing it in a cradle. One man may obtain a ton of iron ore per diem by this process.

Fleet of Portuguese Men-of-War (Physalia pelagica) off the Isle of Wight.—This beautiful Medusa, which, as its name indicates, is oceanic, has lately made its appearance in great numbers off the Isle of Wight after a storm. Many of them were alive, and lived two days in a basin of salt-water. They are very rarely taken on British shores.

The Royal College of Surgeons of England has recently purchased for its museum a collection of specimens of animals from Professor Hyrtl of Vienna. The chief object of interest was the skeleton and stuffed skin of a little animal, the Chlamydophorus Truncatus. This creature is about the size of a rat, and possesses certain anatomical peculiarities, concerning which Professor Hyrtl published a monograph in 1855. On this account, and also for its extreme rarity, the sum of £40 was given for that object alone. There are but two specimens known of: one is in the Anatomical Museum of the London Zoological Gardens; the other is the one mentioned above. Neither are there likely to be any more seen; for the only place in which the Chlamydophorus has been found was in the town of Mendoza, in the high lands of Chili, and which was totally buried, with its 14,000 inhabitants, by an earthquake in the Andes, in 1861.

Plate XIII



W. West Lith.

Fresh Water Polyzoa.

OUR FRESH-WATER POLYZOA.

BY THE REV. W. HOUGHTON, M.A., F.L.S.

OF all the beautiful forms of animal life that tenant the waters of our rivers and ponds in marvellous profusion, there are none, I think, that excel, and few that equal in elegance and interest, the Polyzoa. It is invidious, perhaps, to draw comparisons in nature, where all is perfect; the naturalist will see as much to admire in the common earthworm as in the rarest and most prized zoological treasure, not that in external form the humble worm recommends itself as an object of attraction, but because its structure, like that of every created thing, is so admirably adapted to the wants and habits of the animal. Be this, however, as it may, there is no doubt that beauty of external form, although it may be the only point for which the uninitiated care, is an additional charm in the eyes of the zoologist. Who does not remember the thrill of pleasure that ran through him when first he beheld, through the magic crystals of the microscope, a group of *Vorticellæ* with their delicate spiral stems and ciliated glassy bells? or who that has ever watched the beaded *Melicerta* mould its tiny round bricks, and then bend itself down and add pellet after pellet to its tube, will say he has not experienced a more than ordinary treat, and a kind of gratification which it is impossible to describe?

This is the month of April, and it is too early to attempt to find specimens of any of the species of Polyzoa, with the exception of *Fredericella Sultana,* of which more anon. Still, take your collecting bottles and pocket lens, and come along with me: I shall be able, I know, to teach you a useful lesson in the art of discovering Fresh-water Polyzoa; for you must know that it is quite possible you may be living close to a pond in which live hundreds of one of the most prized species, and yet be quite unable to find a single specimen. We will go to this large reservoir, which supplies the canal; here the water is beautifully clear, and in the summer time the willows and alders on the margins of the bank form a pleasant shade, and ever and anon let fall their dead branches into the water, a favourite object of attachment to all this group; here grow, but not too closely together, several aquatic plants,— water crowfoot, amphibious Persicaria, the copper-coloured Potamogeton (*P. perfoliatus*) with transparent leaves like goldbeater's skin, and other plants of the water.

Now let us go to some sheltered spot or corner of this great pool, to which the wind has blown all the floating rubbish, tangled masses of Confervæ, decayed roots of grasses, feathers of birds, etc., and dip our bottles into this heterogeneous mass. Never mind the ironical smile of yonder angler, who, proud of the pike of twelve pounds weight which he has just succeeded in landing about twenty yards from us, accosts himself in rather a loud tone with "What, in the name of fortune, can that fellow be grubbing after?" No doubt you represent in his mind that very eccentric old fellow who, as sung by the author of the "Ingoldsby Legends,"—

> "Would pore by the hour
> O'er a weed or a flower,
> Or the slugs that come crawling out after a shower.
>
> * * * *
>
> Still poking his nose into this thing or that,
> At a gnat, or a bat, or a cat, or a rat,
> Or great ugly things,
> All legs or wings,
> With nasty long tails arm'd with nasty long stings."

You are used to this sort of thing, and continue your dabbling in spite of it all. Now look into your bottle, and you will see several small, dark, round bodies, about the size of a pin's head perhaps; take three or four out, and examine them singly on your hand with your lens. "They are slightly convex on one side, and concave on the other." "Then they are of no use except as indicators; they are merely the separated discs or faces of old specimens; try again." "Now what have you?" "Why, a mass an inch long, and of an oval shape." "These agglomerated masses are to be depended on, so we will take them home, and in due time you will see them germinate." These little bodies are the product of the most beautiful of all the Fresh-water *Polyzoa*, and of one which is generally considered to be somewhat rare, viz., *Cristatella Mucedo*, the only locomotive species; for, unlike the rest of the family, *Cristatella* is unattached, and being possessed of a muscular base, strongly resembling the foot of a gasteropodous mollusc, the colony is enabled to move about, slowly, it is true, upon the surface of submerged weeds, stones, etc. But it is extremely difficult to detect the presence of adult forms of *Cristatella*, on account of their transparency, d the fact that they live for the most part upon weeds which are generally covered with scum, and the faded filaments of Algæ of the same colour as the animals. Therefore, if you are desirous to learn whether any mill-pool or lake contains *Cristatella*, the better plan is to search for these round black bodies (which Professor Allman has designated *Statoblasts*) late in the autumn, or in winter, or in early spring, rather than for the mature animals. The same advice, too, will be found good in the case of other Polyzoa. These statoblasts are always to be found, and generally in very great abundance, floating in the water, so that all that is necessary is, to dip your collecting bottle in, or to skim the surface; the statoblasts are so characteristic of the different species to which they belong, that you can never doubt what kinds your pond supplies.

If, however, the fully-developed colony is the object of your search—I am speaking of *Cristatella*,—then in the months of June, July, and August you should visit the pond. And here let me give a bit of advice: lie flat down (the *Cristatellæ* are almost always within a few feet of the bank, covered by water varying from an inch in depth to about two feet), and with your eyes close to the surface of the water, and with as little disturbance of it as possible, gently clear away the floating weeds, and examine the submerged stems of the plants *in situ*, just as they grow in the water; it is of little use to pull the weeds out of the water, and then examine them, because it is almost impossible amid the converfoid growth which covers the plants to detect the collapsed form of your much prized *Cristatella*, so you must "stoop to conquer." Probably for a minute or two you will see nothing like the object of your search; but be patient, continue to gaze, and you will most likely be rewarded by observing, amid the scum and confervæ, an oblong-shaped feathery object, about one inch or more in length perhaps, of a pale yellow colour, bearing some resemblance to the well-known gelatinous egg nidamentum of *Limneus stagnalis*. This is *Cristatella Mucedo*, the queen of Polyzoa; and if you are not gratified at the sight of her extreme beauty, as you gently place her with the weed to which she is attached in your collecting bottle, and if you have not an intellectual treat over your microscope when you get home, it is clear you are no judge of beauty.

The attached forms of the Fresh-water Polyzoa are not nearly so difficult to find; at least, I speak of those species with which I am familiar—such as *Alcyonella fungosa*, very readily found and common everywhere, three or four kinds of *Plumatella*, and *Fredericella Sultana*. This last-named species appears to be a singular exception, in one respect, to the rest; for while they seem to be strictly annual in their duration of existence, *Fredericella* is perennial. At any rate, I have discovered it in mid-winter, and at all other periods of the year; and that this species is perennial is rendered probable by the fact that the statoblasts are very sparingly produced when compared with the immense profusion yielded by other kinds. The attached forms of the Fresh-water Polyzoa are readily found, if the collector will patiently examine submerged branches of trees, or the under-side of leaves and stones; for the large sponge-like masses of *Alcyonella*, the branching tubes of *Plumatella*, and the tangled interlacements of *Fredericella* are apparent to the eye without an effort—though at the same time, perhaps, if he had never seen a single specimen, he would either not notice them or would fail to discern in them objects of much interest.

The Polyzoa afford a most instructive example of the necessity to pay particular attention to the internal structure and anatomy of any animal, if we would desire to ascertain its place in the animal kingdom. In external form the members of this group bear a very close resemblance to phytoid Zoophytes with which indeed they were long confounded. Now these latter animals belong to the low-organized class known by the name of *Hydrozoa*, of which the common *Hydra* or Fresh-water Polype, may be taken as the type. But the Polyzoa, notwithstanding their resemblance to, are widely separated from this group, and represent in their structure analogies with that section of the molluscan sub-kingdom happily designated by Milne Edwards *Molluscoida*. "You go down," says Mr. Kingsley, "to any shore after a gale of wind, and pick up a few delicate sea-ferns. You have two in your hand (*Sertularia operculata* and *Gemellaria loriculata*), which probably look to you, under a good pocket magnifier, identical, or nearly so. But you are told, to your surprise, that however like the dead horny polypidoms which you hold may be, the two species of animals which have formed them are at least as far apart in the scale of creation as a quadruped is from a fish."* The Polyzoa have now been admitted to their proper place in the animal kingdom, and have been advanced from the sub-kingdom Radiata (now *Cœlenterata*) to that of the Mollusca. "Thus," as Dr. Carpenter instructively remarks, "whilst microscopic research has degraded the Foraminifera from their supposed rank with the nautilus and cuttle-fish to the level of the sponge, it has raised the wheel-animalcules into proximity with aquatic worms and the humble 'sea-mat' (*flustra*), formerly supposed to be a plant, to a position not much below that of the oyster and mussel."†

The Polyzoa having an organization homologous with the

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* Glaucus, p. 33.

† "The Microscope and its Revelations," p. 18, 2nd ed.

Ascidiæ, or tunicated Molluscs, are now accordingly included with this latter group, and form together the section Molluscoida, (the other section being the Mollusca properly so called). A glance at the illustrations will show the general resemblance which exists between a Polyzoon and an Ascidian, but for the determination of the precise homologous organs the reader must refer to Professor Allman's valuable monograph.*

In the Ascidian the respiration takes place by means of internal branchiæ; in the Polyzoon, by means of external branchiæ forming around the mouth a corona of tentacles ciliated and protractile. They have both a distinct digestive tube, which turns on itself and is open at both extremities; the nervous ganglion, though it does not occupy the same position in both animals, is of similar form and of a very rudimentary nature, and is regarded by Allman as a further instance of homology.† The most marked point of difference between the organization of a Polyzoon and a tunicated Mollusc consists in the latter animal being possessed of a heart and a vascular system, while in the Polyzoon no trace of anything of the kind exists.

It will be well now to obtain some general conception of a Polyzoon, which we shall be readily able to do with the figures before us (Plate XIII., figs. 1 and 2), and from the following clear explanation of them by Professor Allman:—

> "Let us imagine an alimentary canal, consisting of œsophagus, stomach, and intestine, to be furnished at its origin with long ciliated tentacula, and to have a single nervous ganglion situated on one side of the œsophagus. Let us now suppose this canal to be bent back upon itself towards the side of the ganglion, so as to approximate the termination to the origin. Further, let us imagine the digestive tube thus constituted to be suspended in a fluid contained in a membranous sac, with two openings — one for the mouth and the other for the vent—the tentacula alone being external to the sac. Let us still further suppose the alimentary tube, by means of a system of muscles, to admit of being retracted or protruded according to the will of the animal, the retraction being accompanied by an invagination of the sac, so as partially or entirely to include the oral tentacula within it; and if to these characters we add the presence of two sexual organs in the form of ovary and testis, occupying some portion of the interior of the sac, and the negative character of the absence of all vestige of a heart, we shall have, perhaps, as correct an idea—apart from all theoretical considerations of homology or derivation from an archetype—as can be conveyed of the essential structure of a Polyzoon in its simplest and most generalized condition.
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> "To give, however, more actuality to our ideal Polyzoon, we may bear in

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* "On the Fresh-water Polyzoa.". Ray Society, 1856.

† *i.e.*, Correspondence of parts.

mind that the immediately investing sac has the power, in almost every case, of secreting from its external surface a secondary investment of very various constitution in the different groups; and we may, moreover, conceive of the entire animal with its digestive tube, tentacula, ganglion, muscles, generative organs, circumambient fluid, and investing sacs, repeating itself by gemmation,[*] and thus producing one or more precisely similar systems, holding a different position relatively to one another, while all continue organically united, and we shall then have the actual condition presented of the Polyzoa in their fully developed state."

Now of these two investing tunics, the outer one is called the *ectocyst*, the inner the *endocyst*.[†] This latter tunic lines the interior of each chamber, and terminates in the tentacular crown (*lophophore*[‡]); it is transparent, and is readily seen in all the Fresh-water Polyzoa, both when the animal is protruded, and when it is retracted within its cell; for a portion of the endocyst always remains "in a permanently invaginated state." The ectocyst, in most of the genera, consists of a tough leathery substance, imbedded in which are silicious and other earthy particles. In *Fredericella* I have noticed that the silicious "frustules," or component cells of *Diatomaceæ*, especially those of *Diatoma vulgare*, enter largely into the composition of the ectocyst; *Cristatella* alone appears to be destitute of an ectocyst. The inhabitant of each cell is called a *Polypide*,[§] a term wisely proposed by Allman instead of *Polype*, which should now be confined to the animals belonging to the Radiata; the whole dermal system of a colony is known by the name of *cœnœcium*.[‖] The very curious valve-like organ, like a tongue, which arches over the mouth, and which all the fresh-water species, except *Paludicella*, possess, has received the name of *epistome*.[¶] The presence or absence of this organ, whose function, by the way, it is difficult to determine, gives the name of the *order* to which the numerous species respectively belong. Those Polyzoa which are furnished with a bilateral tentacular disc, and whose mouth is provided with the tongue-like organ described above, are placed in the order *Phylactolæmata*,[**] to which are referred all the fresh-water species, except *Paludicella*, and none of the marine except *Pedicellina*; while the species destitute of an epistome, and which have a circular tentacular crown, belong

[*] i.e., Budding.

[†] *Ectocyst*, from the Greek *ektos*, "outside," and *cystis*, a "bladder," or "bag." *Endocyst*, from *endon*, "inside," and *cystis*.

[‡] From *lophos*, "a crest," and *phoreo*, "I bear."

[§] From *polypous*, "a polype," and *eidos*, "resemblance."

[‖] From *coinos*, "common," and *oikion*, "a house."

[¶] From *epi*, "upon," and *stoma*, "a mouth."

[**] From *phylasso*, "I guard," and *laimos*, "the throat."

to the order called *Gymnolæmata*,* which comprises nearly all the Marine Polyzoa. The space included between the endocyst and the alimentary canal is termed the *perigastric space*.

Let us now take a specimen of *Cristatella Mucedo*, and observe those other details of structure or economy which require consideration. You cannot select a better specimen for study than this beautiful species, which, unlike some of the other Polyzoa, is not at all particular, nor shy of being treated roughly. The Polypides protrude themselves most good-temperedly from the orifices of the cells, and if a sudden shock to their rudimentary nervous system causes them to contract within their chambers, they will pop out again almost immediately; while some of the *Plumatellidæ* are occasionally very shy in making their appearance. Sometimes you may be obliged to force the Polypides out of their cells in order to see whether they are alive or not, a fact which is easily ascertained by the ciliary motions of the tentacula.

The engraving (Plate XIII., fig. 3) is copied from a drawing, made by a friend, of a living specimen of *Cristatella* taken last July, and is magnified about two and a half diameters. The colony, which varies in length from between half an inch to about two inches, is of a long oval shape, yellowish in colour, with large dark spots, which are the statoblasts imbedded in the cænæcium, and with smaller ones which are pellets of fæcal matter. The upper surface is convex, and around the margin there are three regular concentric series of Polypides alternating one with another, while the central portion of the cænæcium is unoccupied. This arrangement is not seen in the drawing, because the portrait was taken soon after the specimen had been taken out of the collecting bottle, and before it had time to assume its normal position. The under-surface consists of a flattened muscular disc, by means of which the little colony attaches itself to submerged weeds, or moves along from place to place. The tentacula are very numerous, from seventy-five to eighty in number; they are hollow, and communicate with the lophophore and the perigastric space. The cilia, which are always seen to vibrate in an upward direction on one side of a tentacle, and downwards on the other, answer the double purpose of respiration and of supplying, by the currents they produce, food for the little inhabitants of the cell, which food consists chiefly of Desmideæ and the spores of Algæ.

The lophophore, in most of the Fresh-water Polyzoa, presents the form of a crescent, or a horse-shoe;† in *Fredericella* this crescentic form is not at all obvious; but, according to Professor Allman, this species really presents no departure from this type, though the arms of the crescent are obsolete. The digestive tube consists of mouth, oesophagus, cardiac and pyloric cavities of stomach, intestine, pylorus, and anus. The muscular system is well developed: Allman describes eight different kinds, the most obvious of which are (1) the powerful retractor muscles by means of which the entire Polypide is drawn within the cell; (2) the rotatory muscles of the crown, whose action it is to rotate the crown and depress the lobes; (3) the anterior parieto-vaginal muscles, by means of which the invaginated* endocyst is dilated, and kept permanently inverted; and (4) the posterior parieto-vaginal muscles, whose action "steadies the sheath, and regulates its position during the protrusion of the Polypide."

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* From *gymnos*, "naked," and *laima*.

† Whence the term, *Hippocrepia* (*hippos*, "a horse," and *crepis*, "a shoe), proposed by M. Gervais to designate the Fresh-water as distinct from the Marine Polyzoa, to which latter group he applies the term *Infundibulata* (funnel-shaped).

The Fresh-water Polyzoa increase by true *ova*, by *gemmæ*, and by *statoblasts*. The ova, which are formed in a true ovary after escaping into the perigastric cavity, are there most probably impregnated by the free spermatozoa; but how the ciliated embryo escapes from the cells it is not easy to determine, seeing that no orifice has yet been detected through which it might effect an exit. The gemmæ (or buds) originate in the endocyst as small tubercles which project into the perigastric space, but soon appear as little vesicles projecting from the exterior of the parent cell; in these vesicles the Polypides are gradually developed. The points at which the vesicles sprout forth, determine, of course, the ultimate form assumed by full-grown specimens. The statoblasts are bodies of a very peculiar kind (see Plate XIV., figs. *b*, *c*, *d*, *e*), which are produced as small buds upon the posterior *funiculus*, *i.e.*, a curious cord-like body attached to the base of the pyloric cavity of the stomach at one end, and to the testis at the other. At first these statoblasts are colourless and almost transparent; in time they assume a dark brown colour, and acquire a leathery consistency, when they separate from the funiculus and fall free into the perigastric space, where it is probable they remain until they can gain an exit when the Polypide dies, and the destruction of its soft parts allows an escape through the orifice. This, I believe, is the only way of accounting for the escape of the statoblasts in most of the genera, as Professor Allman is convinced; but in the case of *Cristatella* the statoblasts remain clustered together by their marginal spines, and are not emitted singly; on the destruction of the tissues of the colony they are liberated, and either float on the surface of the water or attach themselves to submerged weeds.

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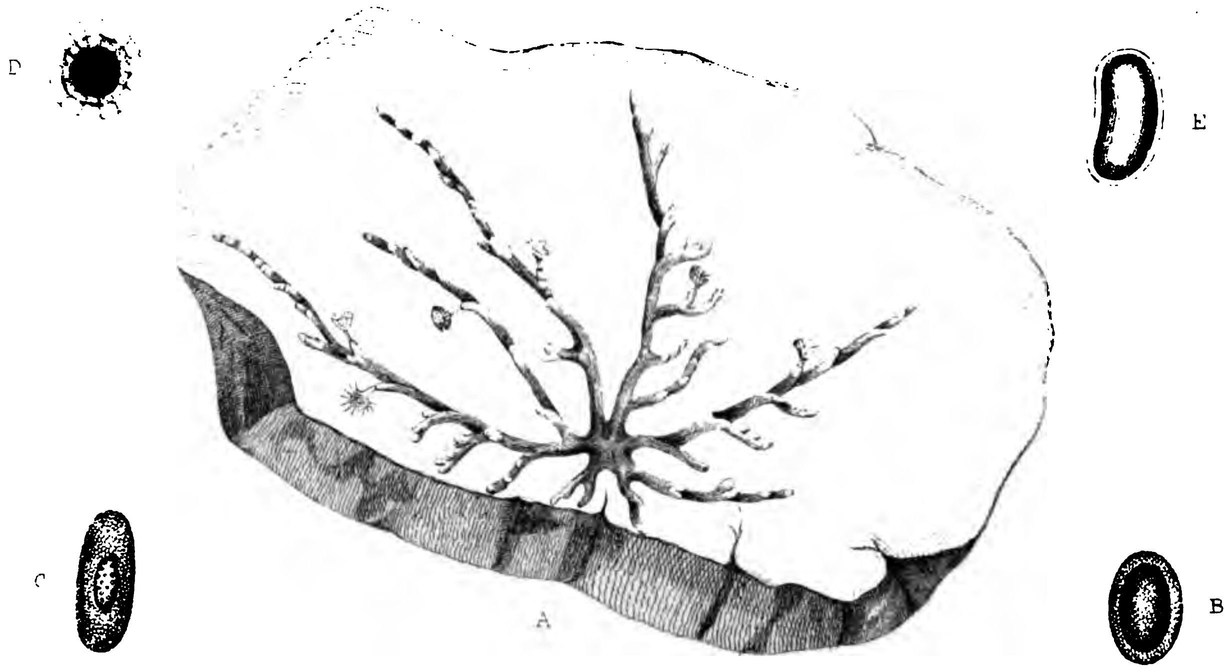
* *i.e.*, sheathed, or drawn backwards into itself, as may be done with the *finger of a glove*.

Plate XIV.



Plumatella repens. *(attached.)*

W West Lith.

The young animal makes its appearance in the spring of the year as a single Polypide, which, however, quickly produces others, until the colony attains the size of one or two inches by July and August, at which time there may be found an immense profusion of statoblasts in most of the genera.

The Fresh-water Polyzoa may be kept alive in a vessel of water for two or three months if care be taken to supply them with abundance of food (for they are voracious feeders), and to keep them well shaded from the light, for all the species, except *Cristatella*, love dark habitations. I have found *Fredericella* the most long-lived in an aquarium. As an instance of the capacity of a Polyzoon's appetite, I may record that a few years ago my aquarium was almost as green as pea-soup from the abundance of algæ spores; I put a good sized specimen of *Alcyonella fungosa* into the water, and in about an hour's time it was quite clear.

Most of the Fresh-water Polyzoa prefer clear lakes and mill-pools, but *Alcyonella* is by no means so particular, being found in water where there is much mud; *Alcyonella fungosa* assumes a spongoid form and grows to a very large size; the interstices of the cænæcium harbour a multitude of all sorts of aquatic animals, Annelids, Crustacea, and the larvæ of various insects, &c., &c. It is advisable to pay attention to these hosts of *Alcyonella*, as some few years ago I was rewarded by the discovery of a very rare worm, whose occurrence in this country rested on doubtful evidence; this was the Fingered Nais (*Proto digitata*), which protruded the curious digitiform segments of its tail out of the mass of *Alcyonella fungosa*.*

The Fresh-water Polyzoa have not been studied in this country at all as they deserve; it is true that we have Allman's admirable monograph of this group, in which work all known species are described and figured; but it is probable that careful searches may reward the collector with the discovery of new species, while his observations may tend to throw light on some points of their economy which require elucidation.

Professor Allman enumerates sixteen *British* species, and believes the number of known species to amount to twenty-one. It is curious to notice that until within the last few years not a single species of Fresh-water Polyzoa had been discovered south of the Mediterranean in the Old World, or of Philadelphia in the New. In 1860, however, Mr. C. D'Oyly H. Aplin found several specimens of this family, comprising at least two species, in Australia. One specimen he described† as having elongated statoblasts, closely resembling Allman's figure of *Plumatella emarginata;* the other was unlike any figure in that gentleman's monograph.

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* See "Annals and Magazine of Natural History," Dec., 1860, p. 393.

† Ibid, p. 454.

According to Dr. Fritz Müller ("Archiv fur Naturgesch." 1860, p. 312), there exists in some of the marine members of this group a *colonial nervous system,* in addition to the individual nervous system alluded to above. By means of this colonial system the movements of the general body are controlled. It is quite probable that careful microscopic examination may result in the discovery of a similar organization in *Cristatella,* and other fresh-water species.

EXPLANATION OF PLATES XIII. AND XIV.

Plate XIII.—Figs. 1 and 2. Plan of a Polyzoon : (1) exserted, (2) retracted.

Fig. 1. *a*, mouth and tentacles ; *b*, alimentary canal ; *c*, anus ; *d*, nervous ganglion ; *e*, investing sac ; *f*, *f'*, reproductive organs ; *g*, retractor muscle.

Fig. 3. *Cristatella Mucedo.*

Fig. 4. Plan of an Ascidian Tunicate. *a*, triple investing sac ; *g*, respiratory apparatus ; *n*, mouth ; *o*, œsophagus ; *p*, stomach ; *q*, intestine ; *r*, anus ; *u*, nervous ganglion ; *v*, heart.

Fig. 5. Plan of a Fresh-water Polyzoon, showing homologous parts with Fig. 4. For explanation, see Fig. 1. Figs. 1, 2, 4, 5, after Allman.

Plate XIV.—*a*, *Plumatella repens*, attached to a stone (natural size) ; *b*, statoblast of ditto ; *c*, ditto of *P. fruticosa* ; *d*, ditto of *Cristatella* ; *e*, ditto of *Fredericella Sultana* ; (all magnified).

THE AFRICAN LION IN ITS NATIVE HAUNTS.

BY JULES GERARD (THE "LION KILLER").

Translated by the Editor.

THE title of this Journal has induced me to lay before its readers a few observations on an interesting subject in natural history, the treatment of which might perhaps be deemed too popular for any of the scientific periodicals which have higher pretensions than it puts forth to erudition and abstruse investigations; and I trust that these remarks may be the means of calling more general attention to the history of that noblest of creatures, the Lion, than it has hitherto enjoyed in this country.

My observations possess, at least, one advantage,—not an unimportant one in these book-making days,—namely, that of originality: for they are not merely a narrative of what others have seen, or a repetition of what my predecessors have written, but are the results of my own personal experience. My knowledge of the lion's natural history has been acquired in those wilds of which he is the sovereign ruler. I have met him face to face as he approached the encampments of the unfortunate Arabs in search of his nightly meal, have tracked him to his lair on his return from his depredations.

These adventures I have described elsewhere, in a form more suitable for the general reader;* but it is now my intention, as far as the limited space allotted to me will admit, to recall a little of the more solid information which I have obtained during my hazardous expeditions, for the benefit of those who read rather for instruction than for amusement.

Let me first mention, that the result of my observations has led me to conclude that the race of lions inhabiting the northern portions of the continent of Africa is superior to those which are met with in the western and central parts of that continent.

Whether this superiority be inherent,—that is to say, an original quality of the animal,—or whether it is due to the conditions by which the creature is surrounded, I shall not venture to say; but shall be content to substantiate the truth of this assertion by illustrations of its superiority, leaving it to the consideration of better-informed naturalists to fathom the *cause*.

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* "Le Tueur de Lions." Paris: J. Vermot.

The western, central, and eastern portions of Africa have each a variety of lion. The first, which is found between the borders of the Great Desert as its northern limit, and down to the lower basin of the Niger in the south, is a maneless creature, of an elongated form, and whose height is about that of the tiger, with which animal, moreover, it has many points of resemblance.

This variety is a hunter; that is to say, it procures its nourishment by chasing game. For this purpose its instinct teaches it to combine with its congeners in the pursuit of its prey, which is effected under the direction of a veteran leader, who allots to all their proper posts and duties: to the most active and best armed the places of danger, whilst the lionesses and young ones are detached for the purpose of beating the game. By combined action,—nay, it might almost be said by a strategic movement,—the lionesses and their young press forward in an unbroken rank; and, just as in a battue, they drive before them all the animals within their circuit in the direction of the hunting party, their movements being accompanied with a loud clamour. When the prey arrives at the passages guarded by the elders, these spring upon and slaughter it with great rapidity, and probably with little suffering to the victims. Should, however, a rhinoceros or an adult elephant form a portion of the quarry, it is either allowed to pass unmolested, or is brought to the ground by the united attack of several lions. The battue ended, each hunter takes his share of the booty; not, however, without some slight privileges in favour of superior might, which in the lion-world also (in this instance, at least,) constitutes *right*.

When, for example, the chase has been successful, and a great number of animals are slain, no disputes arise concerning the division of prey; but should it happen that there is not sufficient to satisfy the appetites of all, the arrival of the lionesses is awaited, and these are first served: then comes the turn of the males; and lastly, upon the remnants—should there be any—the young people are permitted to regale themselves.

Sometimes, when he grows old, the lion of this district turns misanthrope, and flees from the company of his congeners. In such cases, not being able to take a part in the battues of the community, nor to provide himself with sufficient nourishment by hunting the animals of the forest alone, he becomes a man-eater. Taking up his quarters in the thick brushwood bordering on some village, he seizes the natives in their passage to the fields; and it is not at all uncommon for the traveller to find villages in the basin of the Gambia and Niger abandoned by their inhabitants from this cause.

In these habits, then, and in its elongated shape, the maneless lion of Africa manifests a resemblance to the tiger, and more especially to that of Bengal.

The lion of Central Africa with which we are acquainted appears to belong to the same variety found even as far south as the immediate vicinity of the Cape of Good Hope. It is adorned with a beautiful mane, the disposition of which, falling as it does far over the animal's forehead, detracts greatly from its appearance. This defect, and the elongated form of its jaws, deprive the animal of that majestic air which characterizes its congener in Northern Africa.

The third variety appertains to Eastern Abyssinia, Sennaar, and Upper Egypt, and is distinguishable by its form and colour. With a body thick-set as that of a bull-dog, and fierce and sullen as the latter, this lion would be dangerous in the extreme if it were endowed with strength proportionate to its other qualities. Fortunately for the natives, however, he is small, and possesses nothing formidable beyond his red covering and his vicious disposition.

Dismissing these three varieties of the lion with the foregoing brief comments upon their appearance and habits, I shall now ask my readers to accompany me over the orthodox geographical route across the Great Desert to Northern Africa—a journey more easily accomplished in the reader's company, and on paper, than over the burning sands and under the tropical sun of Africa. This expedition will enable us to make the assertion that the "Lion of the Desert," which has been so frequently described, has no actual existence; and it requires but little consideration to show why the animal is not to be found in that locality. Three things are indispensable to its existence—fresh meat, pure water, and shade for repose. Now, from Timbuctoo to the first oases which are found north of Soudan, there is a distance of not less than 400 or 500 miles to be traversed without the existence of this threefold condition of life for the lion; and the country east and west along its whole length is of precisely the same character. It will therefore be easily understood that no lion could penetrate into, much less establish itself permanently in these desert regions. Beyond this sea of sand, however, and the few fertile islands, the verdant oases which are scattered over it, we come to the great chain of Mount Atlas, which, with its magnificent ramifications, is nobly peopled with denizens of the animal kingdom. Here it is that we find the African lion *par excellence*—the lion of Numidia.

Kazouïni and Dameïri, two Arab authors anterior to Buffon, have described the lion of Northern Africa in glowing colours. Their account commences with the titles of nobility of these large-headed sovereigns of the wilds. He is the "great," the "generous," the "magnificent," the "formidable," the "conqueror," the "irresistible," the "gallant," the "superb," the "invincible," the "devourer," the "courageous," the "intrepid," the "roaring," and eighty-nine other attributes in his praise, being but one short of the number which they accord to the Almighty.

Dameïri subsequently describes a conflict in which he took part between a host of Arab warriors and a single lion. In this affray more than one hundred men and as many horses were placed *hors de combat*, and the lion, pierced with wounds, remained master of the battle-field, the king having given way before so noble and courageous an animal.

This high estimate of the Numidian lion, published many centuries back, accords with the facts which I have collected, and my own observations at the present day.

I have, however, found in Numidia, not one, but three well-marked varieties of lion; and I presume it is in honour of the most formidable of these that the Arab chronicler has recited his narrative. The three varieties of this interesting family known to me are the *fawn-coloured*, the *grey*, and the *black*. Amongst the Arabs they are known as "el Asfar," "el Zarzouri," "el Adraa." The fawn-coloured and grey varieties are bold animals, far superior in external form and muscular strength to their other African congeners, and also dissimilar in their habits.

These great lords hold the principle that to hunt game is a fit employment only for poachers and peasants; and, after the manner of certain barons of the middle ages, they deem it more dignified and convenient to support themselves at the expense of their vassals. Every man, therefore, who stands possessed of a herd of oxen, a flock of sheep, or of a few horses, is, in their opinion, amenable to the levy of tithe and tribute.

Starting upon this axiom (still uncontroverted), the lion just referred to awakes at sunset, and coolly proceeds to some rock in the vicinity of his lair to perform his toilet; and from whence, looking down upon his territories, he can survey the whole surrounding plain, and perceive the various flocks and herds returning to the fold.

When night has fairly set in, he rises to his feet, roars for the first time, and swaying his enormous head from side to side as he proceeds, makes his way with measured pace towards the encampment which is to furnish him his supper.

The very roar of the lion in its wild state, which is a music that even the most fastidious would deem worthy of being listened to, is truly magnificent. His first note, when he commences to roar, is a low sound emitted from the chest and nostrils; but it is audible from a great distance. This is a species of prelude, and immediately afterwards it is repeated, but this time it is much louder and more protracted; the jaws of the animal being still closed, or the mouth but slightly opened. The third and fourth outbursts are given to the air through the fully extended jaws, and with the whole force of the lungs. To listen to this roar is terrible for those who happen to be crossing the monarch's path, or to be marching through the lonely forest. At length, after two or three more utterances of this kind, the animal ends, as he commenced, with less vigorous notes.

The distance to which I have been able to trace the progress of a lion by his roar, when there has been no contrary wind, and no mountain nor other obstacle to intercept the sound, is two or three leagues; but when he roars about a league off, one who is unaccustomed to the sound would believe him to be close at hand.

A curious circumstance which I have noticed, is that when the lion is accompanied by his mate they always roar alternately; that is to say the lioness commences, and the lion answers her, each continuing in its turn to utter its note, but the tones never being mingled. It has afforded me some satisfaction to find that my hero possesses a musical quality, which has never been observed in any other quadruped, so far as I am aware; and I am quite content to leave it to men of science to discover the cause, should they deem the matter deserving of their attention.

But to return to our hungry lion, whom we left descending from his mountain lair to the plain on which the encampments are pitched. By the term "encampment"* the Arabs and natives of Barbary designate an assemblage of tents ranged in a circle, and in close proximity with one another, except in one part, which serves as a passage to and from the plain. In the centre of this circle the herds are penned; and the external enclosure which surrounds and serves as a protection to the tents, consists of a rude hedge from six to twelve feet in height. The aperture or passage referred to is kept open during the day, but is closed at night.

When the Arabs hear the lion begin to roar in the distance they are at once on the *qui vive*. Heaps of wood are piled up before each tent and kindled, so that when the lion arrives near the encampment he may be visible to all, and that the owner of each tent may be able to throw a lighted brand at his head, and drive him forward to his neighbour's tent.

But the king of beasts is so much accustomed to these fires and to the cries of men, women and children, joined with the yells of dogs, that he completely understands their meaning, and regards them with perfect indifference. Like an experienced hunter when he arrives before a hedge, all he does is to take the measure of its height with his eye, and then with a bound as quick as lightning he clears it, and alights in the encampment.

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* "Douar."

Then follows a scene of unutterable terror and confusion. Men, women, and children rush pell-mell into their frail dwellings. The dogs are silent in an instant and seek refuge on the tops of the tents; with desperate struggles the horses break their tethers, and all the large cattle, forcing a gap in the hedge which encloses the encampment, scamper across the plain. The poor sheep, too much terrified to flee, are huddled together in a heap and bleat most lamentably, as though pleading for mercy. But the lion has left his generosity in the mountains, and at this juncture he experiences only his carnivorous instincts. These prompt him to take possession of one of the poor sheep, unless on this particular occasion he prefer to regale himself with an ox or a horse; in which case he pursues the cattle into the plain and commits fearful havoc amongst them.

For, a single victim on one night is not sufficient to satisfy this long-maned gourmand. He needs an ox for his dinner, partaking only of the prime portions, and afterwards the blood of five or six more serves to quench his thirst.

Thus far, we have no right to object to the lion's proceedings. We drink claret, beer, and champagne; he prefers the warm blood of his victims—every one has tastes given to him in accordance with his nature. But the really objectionable part of his proceeding is, that he does not return to devour the animals he has slain, but goes elsewhere and massacres new victims. This need of fresh-killed meat occasions enormous losses to the Arabs, for their religion forbids them to feed on animals which have not been killed by themselves, pronouncing, in so doing, the sacramental words "*bessem Allah*" (in the name of God).

This is the mode of procedure with the grey and fawn-coloured lion when it seeks its meal alone; if accompanied by his mate, the latter remains outside of the encampment, and her lord, clearing the enclosure, manœuvres in such a way as to drive a portion of the cattle to the locality where she is stationed. Madame selects her victim, slaughters it adroitly, and at once sets about her meal, never permitting her spouse to partake of her repast. Neither does he attempt to touch one of the slaughtered animals which lie around, but looks on patiently until his spouse has finished her meal: his behaviour, let me add, serving as an example worthy of imitation by all married men. I have even noticed, that when he approached his mate, apparently with a view to inquire whether her food was palatable, she would respond to this delicate attention on his part by demonstrations of anger, without at all, however, disturbing *his* serenity.

But the excellent domestic qualities of the wedded lion do not end here. When he has attained the felicity of being the parent of two or three young ones (the average number of young in the family of a pair), he is charged, during the daytime, with watching over the safety of all, and at night it is he who sets out to the distant plains in pursuit of prey, to furnish sustenance to the mother and her young cubs.

In the performance of this duty, the lion has recourse to an expedient well worthy of the consideration of scientific men, and calculated to puzzle those who disbelieve in the magnetic power of animals. As the lair inhabited by the lioness and her young is always at a considerable distance from the Arab encampments, it would be a difficult task for the lion to carry, or even to drag, an ox or a horse so far. To avoid this labour, he brings home a living animal. Yes, reader, incredible as it may appear, the lion possesses the power of compelling a bull to leave the herd, and can force it to precede him, in whatever direction he pleases, for a whole night, thus leading him into the most inaccessible mountains.

Let me relate a circumstance connected with this power possessed by the lion, of which I was myself an eye-witness, my rifle having on that occasion solved the strange problem:—

In the month of May, 1846, an expedition set out from the camp at Guelma towards the frontiers of Tunis, for the purpose of chastising a rebellious tribe of Arabs.* At seven in the morning of the second day of our march we arrived at the banks of a river called El Meleh Salée, which flows past the foot of a bare precipitous mountain. At this place we halted, and Captain (now General) de Tourville ordered the cavalry to remain until the infantry and baggage had passed over the hill. We had been there about an hour, when we saw a horseman gallop back to us at the top of his speed. This horseman was a spahi, who formed part of the escort, and having reached the leader of the cavalry, we saw him address him with great animation and many violent gestures, which led us to believe that the vanguard had been, or was about to be attacked. Presently, however, I heard my own name frequently repeated, as though some one was wanted on a pressing service. I hastened to join our commandant, and this is what I learned from the Arab—his statement being received with the utmost incredulity by those who stood around:—

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* M. Gérard was then, and is still, an officer in the French army. His early life, and lion-hunting adventures are described in his work, already referred to, "Le Tueur des Lions." A few lines concerning him will be found at the end of this paper.—Ed.

At the moment when the head of the column had reached the summit of the hill, the vanguard perceived a bull approach across the corn-fields, and behind it, only a few paces distant, was an enormous lion which followed its footsteps. The soldiers at once set up a great cry, the drums were beat, and the clarions sounded. This noise arrested the animals for a moment, and then they proceeded onwards, in the direction of the troops. As they were not above a hundred paces distant the men prepared for a volley, when the commander and officers gave orders not to fire, but to halt.

The bull and lion crossed the path on which the troops were about to march, within pistol-shot; the lion then lay down to survey this spectacle which was so new to him, and the bull commenced grazing close by his side.

It was at this juncture that the spahi was despatched to fetch me; and it is hardly necessary to say that, notwithstanding the distance and the difficulty of the road, I was not long in reaching the scene of the strange apparition. The lion was, however, no longer there, and I had to follow his track. On arriving at a little hillock I saw him on the slope of a mountain opposite, still preceded by his victim. Having heard the gallop of my horse and that of the spahi who accompanied me, the lion had stopped, and was watching our approach.

The bull had followed his example. When I had arrived at about a hundred paces from him I dismounted and walked towards him, preparing my rifle. The lion politely advanced to meet me, and when we were distant from one another about twenty-five or thirty paces I stopped, and fired my first ball, which turned him on his back. He, however, rose instantaneously, and with furious roars bounded towards me. More fortunately or skilfully aimed, my second shot stopped his infuriated career in time, and brought him to the ground.

As for the bull, he was led to the bivouac the next day, and I ascertained from the Arabs of the district in which we were, that he belonged to an encampment situated at least twelve miles distant from the locality in which we had encountered him; and that each night of the previous month had been marked by an abduction of the kind, the victims serving as food for a lioness and her cubs which inhabited a neighbouring lair.

I confess that when I heard this news, I regretted the mischief which I had unconsciously occasioned. My readers will doubtless consider the care and affection manifested by the lion towards his mate and young ones as laudable as I do; and as to the question of magnetic influence, I can only explain it on the ground of extreme terror; for there are many examples cited of Arabs thus magnetized and led away by the lion, in the presence of other persons who had sufficient presence of mind not to succumb to his influence.*

The variety of lion to which I have been referring is, in every other respect, a pattern of domestic virtue, which is more than can be said of his mate; but as I have now almost reached the limits of the space allotted to me I must leave them to settle their differences, and conclude this brief and imperfect account of the habits of the king of beasts with a few remarks upon the last variety, the black lion, which is the finest and most formidable of the species.

This animal is not so common as the fawn-coloured or the grey one. Like the two latter, it takes six or eight years to arrive at its full growth, and its life is of fifty or sixty years' duration. With somewhat shorter legs, it is broader and more thickset than they are. The power of its jaws, chest, loins, and paws is so great, that it can clear an enclosure eight or ten feet high with a horse three years old between its teeth. I have myself witnessed this feat on more than one occasion. His habits pretty much resemble those of the two last-named varieties up to the age of twenty or thirty years, but then he becomes a man-eater, and causes terrible ravages on the frontiers of Tunis and Morocco, where he is the most frequently met with. The courage of this lion is really grand. It matters little to him by what numbers he is attacked, and whether it be by day or by night, he never flinches. I have seen one of these black lions charge into the midst of 300 Arab horsemen on an open plain, and drive them back almost to their encampment; the boldest of them with their horses remained prostrate along his path. I have sometimes found the grey or fawn-coloured lion hesitate when I met him at night on my expeditions through the forest, but never this one. The black lion always looked me full in the face, without any demonstration of anger, before the attack, but regarding me with disdain, as if I were an inferior being. In fact he is the most *beautiful* animal *before*, and the *noblest after*, man himself.

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* It is not our intention to enter upon the discussion of the subject of the fascination exercised by animals over their prey; but we may mention that there are many instances on record of a somewhat similar power being possessed by other animals. An anonymous writer, in the "Leisure Hour" (Nov. 1862), gives some examples of it in the stoat: he watched a rabbit trying to escape from the fascinating power of a stoat, around which it circulated, as if spell-bound, "continually narrowing the circle in which it was running, whilst the stoat seemed to be watching for it to come near enough to spring at." The narrator shot the stoat, and the rabbit then escaped. If, in our author's case, the bull had made an effort to escape when the course of the lion was arrested, it would have been easy to explain the fascination on the same ground as in the case of the stoat and rabbit. We would also draw attention to the remarks on this subject in the review of Hartwig's "Tropical World" in our present number.

Fortunately for him, he has not yet become acquainted with the martyrdom of captivity, for I cannot otherwise designate the cruel and thoughtless mode of securing him in zoological gardens.

Here is a creature which, more than any other, has need of air and space, and he is imprisoned in a cage in which he can hardly turn himself. But the money requisite to supply the place of those which thus die a miserable death would amply suffice to afford them an extent of ground similar to that reserved for deer and other less noble animals; and we should then possess creatures magnificently proportioned, instead of poor, sickly, emaciated forms; and they might be watched as they play and bound in fact almost as in a state of nature.

There is still something to be done in this respect, and sooner or later it will be accomplished, for the English are an earnest, practical people. Meanwhile, should any of my readers happen to be Fellows of the Zoological Society of London, I would just give them a friendly caution against making the mountains of Africa the scene of their vacation tours, lest the lions at large should take vengeance upon them for the unfortunate fate of their brethren held in captivity.

The author of this paper, M. Jules Gérard, is but little known in England; and it is only recently that his name has appeared somewhat prominently in connection with his lion adventures in Northern Africa, and his projected journey of exploration into the western equatorial territories of that continent.

The following details will, we trust, have the effect not only of giving additional interest to his little essay here published, but of enlisting for him the sympathies of our readers in his hazardous enterprise.

M. Gérard is an officer in the Franco-African army; but his recent reception here, and the object which he is now seeking to attain with English co-operation, are likely to associate his name with this country more intimately than with Northern Africa, the scene of his lion-hunting adventures, or with his native land.

He left Liverpool in excellent health and spirits, on the 24th *of last February*, by the steamer "Macgregor Laird" (a name of good omen, as he said before leaving), for Lagos, accompanied only by a photographic assistant; and from that place it was his intention to proceed to Whidah (where the slaves are shipped), and. thence through the possessions of the cannibal King of Dahomey to the river Niger.

We hope to be able to communicate further details of his route in a future number; meanwhile, we may mention under what circumstances he set out.

His reputation for bravery preceded him from France, and gained for him the goodwill of every class of society. Sporting men, from noble dukes downwards, made him their companion and friend. The Ministers of Foreign Affairs and of the Colonies, the merchants of Liverpool, the manufacturers of Manchester, and scientific men in every place that he visited, lent him their aid, "material and moral;" and before his departure, the Royal Geographical Society presented him with a set of excellent instruments to enable him to take accurate observations on his geographical tour.

But it is chiefly to the friendship of the Duke of Wellington that he owes his good fortune, and if it please Providence that another adventurous and high-minded man should penetrate into the gloomy regions of cannibalism and the slave-trade, and that he should do something to mitigate the horrors of these most fearful of human crimes, much of the result will be due to the prompt and generous support afforded by his Grace* to our author, nay, we may say our hero, at the most critical period of his projected undertaking.

As M. Gérard is not here to read our eulogium (for that he is as modest as he is brave all will say who know him), we may state that he is in every respect peculiarly fitted for his mission. As far as a somewhat brief acquaintance has enabled us to judge, he combines with the courage and determination of a soldier a gentle disposition, (which was pained when he found he had deprived the lioness and her young of their protector), scrupulous honour, French politeness, and English friendship; and if a good shot, an unbending will, and the winning ways of a man of the world be of any avail, M. Gérard will command as friendly a reception from his Majesty of Dahomey as he has experienced in civilized society in England.

When he started, he spoke with great confidence of the establishment of a colony and trading station in some healthy portion of the interior of western equatorial Africa, and we trust that in the cause of civilization and progress, as well as for his own sake, his enterprise may be carried to a successful issue.

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* Also by Earl Russell and the Duke of Newcastle.

BRITISH FUNGI.

BY MISS MARGARET PLUES.

> "The turf
> Smells fresh, and rich in odoriferous herbs
> And fungous fruits of earth, regales the sense
> With luxury of unexpected sweets."
>
> COWPER.

IT is a very general complaint during the autumn and open winter weather that there is nothing for botanists to find, and therefore no encouragement for them to extend their rambles beyond the dry limits of that most wearisome of all exercises, a "constitutional walk." Those who thus decide, do a grevious wrong to a large and curious race of plants, whose structure is as wonderful as that of the gayest exotics, and their colours in many instances scarcely less brilliant, and which have their uses too, both medicinal and gastronomic; also—what is generally most attractive—their dark and mysterious dangers. The Fungi are an ill-used race; under the name of Toadstools we insult them from earliest infancy. Flowers are often ruthlessly plucked, quickly to be cast aside and forgotten. Ferns, though the rage of the day, sometimes share a similar fate, and the mossy garland or basket is left to wither unnoticed; but such an end is too good for Fungi. "Ah, nasty Toadstools!" we say, and proceed to *kick* them over. Yet nowhere can we find more variety and purity of form, or more brilliancy of colouring. Let us do justice to the Fungi, examine their merits—ay, and their demerits too,—and then the woods will not lose their charm for us in autumn, nor even in winter.

Fungi, like most other plants, have three parts: *spawn*, which performs the function of roots; *expanded portion*, as the stem and cupola of the Mushroom, the branches of the *Clavaria*, or the cup of the *Peziza*, which answers to the stem and leaves of other plants; and *spores*, which answer to their fruit. The whole substance of a Fungus is formed of *cells*, generally round or oval, but often, as in moulds, branching in the most fanciful manner.

The order of Fungi is divided into two groups, or sub-orders: *Sporiferous*, where the spore is formed naked *upon* the cells; and *Sporidiferous*, when it is formed *within* the cell, which then becomes a bag, or spore-case. The first group of

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the SPORIFEROUS Fungi is distinguished by the *hymenium*, or *fruit-bearing part*, being open to the air. Our common Mushroom is a familiar example of this group, and stands as a representative of the large family known as *Agarics*. These have a cellular stem, a *pileus* (cap), resembling the top of an umbrella, and *lamellæ* (folds) underneath, upon which the cells are disposed, the spores springing from them; these lamellæ form the hymenium. In our autumn rambles we frequently come upon brilliant scarlet mushroom-shaped Fungi, their gaudy tops all flecked with white. These, as well as the Common Mushroom, belong to the Agaric group. They are enveloped in infancy in a *volva* (wrapper), which tears away as the pileus expands, leaving pieces like white felt adhering to the crimson covering. This *Amanita muscifera* is highly poisonous, and is used to make fly-poison in Britain; but it is employed in Kamschatka to make an intoxicating drink. It thus exhibits a peculiarity, not rare in its class, of the qualities being wonderfully altered by climate. Many species, deleterious in their properties here, are wholesome in Italy, and the Fuegians are nourished by some which to us would be wholly poisonous. A nearly-allied species (*Amanita rubescens*) with a brown pileus, but flecked in youth with scraps of its discarded volva, I have found in Kent and Yorkshire; its *flesh*, the substance between the pileus and the lamellæ, turns red when it is broken: hence its name.

The spores in this portion of the Agaric group are white. You may procure them for examination by leaving the young plant on a piece of coloured paper, where it will shed its spores. It is easy to examine them with a botanical microscope; their shape and colour at once decide the species. Under fir-trees in autumn I have frequently seen crowds of stately Fungi of this Agaric type, the brown coating of the pileus torn into shreds. This is the *Lepiota Rachodes*; it is round at first, but on reaching maturity the pileus expands, and becomes flat; the thin shreds, which formed a *velum* (veil) in youth, stretching from the edge of the pileus to the centre of the stem, still hang as a frill on the latter, and, along with the white spores, fix its position early in the Agaric group. The White Agaric, which grows in clusters on tan in hothouses, is another Lepiota.

In similar localities to that chosen by the *L. Rachodes*, we find the mouse-coloured *Tricholoma humilis*; the folds are prettily turned where they meet the stem, and tinged with the colour of the pileus, and the velum is hairy. Frequently in woods and field-borders groups of smaller violet-coloured Agarics are seen, the pileus covered with plum-like bloom. The lamellæ are also violet-tinted, and the pileus often twists into eccentric shapes. This is the *Clitocybe laccatus*. I remember being greatly attracted by a group of the salmon-coloured Collybia

Fusipes, growing out of the bole of a tree in an enclosed part of Hope Park, near Edinburgh. I fee'd a "laddie" to climb for them, and admired their umber inflated stems greatly when in my hand. A few of the stems were long, and had burst with the wet, showing their hollow structure. The lamellæ were pale yellow. An allied species (*C. Velutipes*) is common on stumps in woods, the velvet-like texture of its dark-brown stem forming a pleasing contrast with its orange cupola-shaped pileus; while myriads of the fragile mouse-coloured *Mycæna alcalinus* cluster on the same rotten stump, quivering in every breeze, and perishing by dozens as you try to gather them. Some of this numerous clan of Agarics are without a stem altogether, as the little lead-coloured *Pleurotus applicatus*, and the pale-brown biting *Panus stypticus*.

Turning from the Agarics with white spores, we are next presented with a group bearing salmon spores. The little brown "toadstool," with pileus no bigger than your finger end, which you find on lawns, *Naucaria melinoides*, is one of these. Our friend the Mushroom, *Psalliota campestris*, has purplish brown spores. It is said that sheep eat the Mushroom; and I remember being earnestly warned by a countryman not to eat any Fungus I gathered in a field where sheep were; "for it can't be the right kind, or they would have eaten it up," he said. The merits of this friendly Mushroom are numerous; to us it alone redeems its tribe from a great part of the stigma resting upon it. Stewed or made into ketchup, or pickled in the infant or "button" state, who can praise it sufficiently! And then the pleasure of going out mushroom-gathering, basket in hand and emulation in the heart; of wandering through the breezy pastures, reconnoitring from the tops of gates for white cupolas, and being quizzed unmercifully should they turn out to be lumps of chalk!

Who is there that has not noticed the cone-like Fungi springing suddenly after rain upon the lawn, often pressed so closely together as to push each other sadly out of shape? These vary from the typical Agarics in their lamellæ melting away, so that the spores flow away in the liquid substance of the folds, leaving, in the place of the *Coprinus atramentarius*, a mere stain, as of ink, upon the sward. Closely allied to this, though varying greatly in appearance, is a tiny Fungus which takes up its abode on the plaster of dwelling-houses. I was much puzzled on one occasion to find a starry network on my bedroom ceiling; it was as if threads extended in every direction from a round nucleus in the centre, like a flattened pea, and branches issuing from the threads, and interlacing wove the whole into a circular network. The little plant in the centre was the *Coprinus radians*; the branches, etc., were mycelium (spawn) thrown out to draw moisture from the air for that nourishment which the plaster could not afford. A watery texture marks the sub-genus *Hygrophorus*, but they do not melt entirely away like their relative the *Coprinus*.

The green-tinted Agarics which adorn the sward upon the chalk downs belong to this family (*H. psittacinus*), as do also the gaudy orange conical ones which flourish in meadows in autumn (*H. conicus*). These same chalk downs are the grand *locale* for the *Marasmias oreades*, the mysterious cause of those fairy rings concerning which so much romance and sentiment has been told and sung. It is a pale, unassuming looking fungus, and perfectly wholesome; but who would like to dine on fairy rings! Surely, as a just punishment, they would be bewitched, and, at the least, pixy-led. Yet this very plant used to be sold in a dry state in Covent Garden Market.

Varying from the true Agarics in having the hymenium in *veins*, instead of upon lamellæ, the group of *Cantharellus* is yet very nearly allied to them. The Chanterelle, once so much prized, and still used in France, is frequent in our woods from Berkshire to the Northern Highlands. The groups, so variable in form but so rich in colour, of the *Cantharellus cibarius* form attractive objects beneath the overshadowing oaks, while the darker hue and elegant form of the *C. cornucopioides* wins enthusiastic admiration from the naturalist wandering in autumn and early winter among the mossy woods of Herefordshire — it is well named after the cornucopia, which its contour exactly resembles. The rare *Lentinus flabelliformis*, stemless and with fleshy lamellæ, once rewarded my search in Wiltshire, growing round the base of a turnstile post upon the greensand formation. The *Lenzites betulinus*, similar in form, but of a corky texture, is frequent upon stumps of birch in that same neighbourhood; its zones of olive and green and its downy pileus render it an ornament to the otherwise naked stumps. There is a group of Agarics with milky juice; these are very poisonous. I remember blistering my lips with only touching them with the biting juice. Old Gerarde recommends us to confine ourselves to the "Meadow Mushroom" for dietetic purposes, adding, "It is ill trusting any of the rest;" and until our knowledge is more extended, and our observation more on the alert, I think we had better follow his counsel, although we cannot agree with his quotation from Pliny, that "mushrooms grow in showers of raine, *they come of the slime of trees*."

In the next group to the Agarics we find the hymenium in tubes or pores, more or less broken; hence the group receives the name *Polyporei*. We find Fungi, yellow, brown, white, or tawny; and, upon administering our accustomed kick, we see a spongy under-surface appear, instead of the lamellæ of the Agaric.

These Fungi we call Sap-balls, or *Boleti*. One is edible (*B. edulis*), and of a pale colour; another is very poisonous and dark tinted (*B. luridus*); the apricot-coloured (*B. piperatus*) is peppery; and we cannot recommend the flavour of the gay yellow one (*B. luteus*). In the *Boletus* family the tubes of the hymenium can be separated from one another. Not so in the next family, that of the Polypores. These grow occasionally with stems, as in the *P. varius*, which I found adorning pollard willows on the banks of the Wye; elegant in form, like a scallop-shell, with the hinge prolonged into a stalk, and the pileus shaded richly with umber and crimson; but more frequently they are stemless, growing like shelves and brackets on tree-stumps. Of these the *P. squamosus* is a very handsome member, spreading to the size of from one to two feet, blotched with brown, and forming a remarkable object on the bole of ash-trees. A very firm, woody, fragrant species grows in the form of a bracket on old willows. I have found it in Wiltshire, Herefordshire, and Kent—*P. salicinus*. A minute plant of this family, *P. abietinus*, adorns fir posts, &c. It grows flat at first, and then the edges curl over in the form of frills; the edges and the hymenium are violet, the pileus white and cottony. Some species, as *P.* [illegible], grow on the ground; the hymenium white, and the edges, which presently turn up, a full chestnut brown.

Few old stumps in woods or on lawns are quite destitute of the zoned frills of the *M.* [illegible]. The pores here are not equally distributed over the surface, but are arranged in branching lines. In texture it resembles parchment. This plant is brother to the Dry-rot, which so constantly brings ruin in its wake; terrible, less in its perfect state, with fully developed pileus and hymenium, than in its spawn condition, when it eats into wood, rendering it rotten and crumbling, and showing no respect for the most hallowed edifice. "It is because the Dry-rot has got in," was the answer returned to my question, why the wall of the curator's house at the Edinburgh Botanic Gardens was taken down; and on putting a similar query to workmen engaged in a Kentish church, I was again told, "The Dry-rot has eaten away both the pews and the flooring." From the perfect plant drops of moisture exude; hence its name, *M. lachrymans*. They might well be tears of repentance shed over its many misdeeds.

[illegible], with its shapeless form and blood-red pileus, is found in the later summer months, growing on trees. It has been recently found in [illegible] Park, Wiltshire, and Stoneleigh Park, Warwickshire. In this genus the pores are not only separated, as in *Boletus*, but distinct and uniform. It forms wholesome food, and I have known persons who have eaten it without bad results, and who describe it as resembling veal cotelette. All credit to them for their enterprise; for we must own it does not look tempting.

Woods both in Kent and Wilts have furnished me with the pale salmon-coloured *Hydnum*. Here the hymenium is in *spines*, which cluster closely over the under-surface, like miniature stalactites from the roof of a cavern. It forms an excellent dish, being likened to oysters. I have also gathered it in September on the banks of Loch Lomond. Another pretty species, smaller, and shaded with madder, grows on mossy banks in Kent (*H. zonetum*); while many stemless kinds grow as incrustations upon decaying sticks. Upon rotting pales and stumps we see richly-tinted patches, some brilliantly purple, others fine umber brown and velvety; these are *Corticium cœruleum* and *Stereum hirsutum*. In these plants the hymenium is quite *even*, not disposed on lamellæ, or in tubes, or veins, or spines, which feature characterizes the *Auriculini* group.

The *Clavariæ* are among the most attractive of our fungi, carrying their hymenium in the upper part of their branches. Some grow as bunches of yellow coral among the low grass on our downs (*C. fastigiata*); others are equally branched, and snow-white (*C. cristata*), and frequent woods; whilst the amethyst tint of the lilac species favours moorlands. I found it on the heights above Oban.

The last group in the hymenium order is the *Tremellini*. These fungi have the fruit-bearing part mingled with their jelly-like substance. The *Tremella foliosa* resembles a plaited mould of port-wine jelly; the *T. mesenterica*, orange jelly; and the *T. albida* might be a piece of semi-transparent blancmange. They grow on dead wood in damp places. The *Exidia glandulosa*, shaped like half a huge black mulberry, and the *Hirneola auricula Judæ*, of ear-like resemblance, both belong to the *Tremellini*; the former growing on dead oak, and the latter on living elder, and lasting through the winter months.

Some years ago a fungus dinner was suggested in the pages of "Chambers's Journal." *Fistulina* was to stand as beefsteak, young Puff-balls for sweetbread, *Lactarius deliciosus* for lamb chops, and *Hydnum* for oysters!

There are also other utilitarian members among our friends. The *Boletus edulis* is much prized on the Continent, and has occasionally been cultivated with success. The *Polyporus fomentarius* forms the *amadou* of commerce, "German tinder" being merely thin slices of the fungus steeped in saltpetre and dried. The Ostyacks use *Polyporus ignarius* as an ingredient in snuff, and the *Pietra funghaia* is merely hard clay penetrated with the mycelium of *P. tuberaster*.

PART II.

> "We'll make a feast in our mossy dell,
> Of infant Puff-ball and rare Morel,
> And many a favoured guest shall sup
> On Lily-dew from a siller cup;
> The aged Puff-balls shall help us to cheat
> The dainty bees of their luscious meat;
> While others shall burn to give us light,
> And scare from our dell the dreary night."
>
> WICKLIFFE LANE.

THE second family of Fungi in the Spore group is called *Gasteromycetes*, and is characterized by the hymenium being enclosed in a single or double bag.

This family contains a group of subterranean Fungi, one member of which, the *Melanogaster variegatus*, used to be sold in Bath under the name of Red Truffle. Its bag or *peridium* is thin, and the spores are disposed on the summits of cells, in the cavities into which the interior is divided. Nearly allied to these are the *Phalloidei*, well known through the undesirable quality of their representative the Stinkhorn (*Phallus impudicus*), more politely named Wood-witch in some counties. Here the plant is enclosed in a peridium in youth, upon the bursting of which the coarsely cellular column shoots up, bearing as a capital a honeycombed pileus, from which the hymenium exudes in greenish jelly of most offensive odour, which, nevertheless, is greedily devoured by flies. This odour resembles that of putrid animal matter, and I remember hearing the owner of some beautiful grounds lament that some rabbits must be decaying among holes in the rocks, for the smell during the last few days had made the grounds unendurable. He did not lay any blame upon the obelisk-like Fungi growing here and there in the said woods, and the removal of which restored the grounds to their original purity.

The *Clathrus*, another member of this family, is yet more offensive in its odour,—though so gay in colour, being crimson and orange, and branched like coral. It is seldom found except in Devonshire.

The *Geaster*, or Earth-star, belongs to the *Trichogastre* group, characterized by its paper-like peridium. One with a double peridium, *G. fimbriatus*, forms a beautiful object: the outer coat bursts and tears into six or seven pieces, which roll back and lie on the ground in a star shape, while the inner coat opens only at the summit, from whence the dust-like spores exude. The Common Puff-ball has a double peridium, the outer part peels off and leaves the inner entire. In the young state some Puff-balls make an excellent and wholesome dish, resembling sweetbreads in flavour: in age they delight mischievous boys, who love to puff the powder into each others' eyes, and they perform a beneficent office towards those domestic insects—the bees—who, intoxicated by the fumes of a Puff-ball burnt under the hive, fall down in coma, and the honey may then be taken without the wholesale murder which is too often the cruel reward for their patient industry Our great-great-grandfathers and grandmothers were lighted to evening parties by these Puff-balls, according to Gerarde; and they were also used for tinder by the succeeding generation.

The Edible Puff-ball is *Lycoperdon giganteum;* it also acts as an anæsthetic, according to Berkeley, and may, in future years, be as useful as chloroform.

A number of minute Fungi appearing on rotten wood in autumn and winter, some resembling rusty nails; others, minute pins, their heads bursting and giving forth red or yellow or grey powder; and others, again, beads also dusty in age, succeed the Puff-balls in botanical order, all beautiful and interesting when closely examined. The *Nidulariacei* is the prettiest group in the family *Gasteromycetes.* The peridium is tough and woody, and opens at the top, giving the appearance of a cup the size of a child's thimble, with packets of spores lying at the bottom, attached by an elastic thread, which jerks them out when ripe. The *Cyathus striatus* I found in Somersetshire, growing upon beech-mast; it is hairy on the outside and beautifully striped within. The *C. vernicosus* was the produce of gardens about Edinburgh, where it adorned the box edges with its bell-shaped cups, and is known by the name Siller Cup; and the smaller species, *Crucibulum vulgare,* was contributed from stubble fields in Shropshire.

The third family of the Spore class is characterized by the whole mass being formed of dust, sometimes enclosed in a cover, sometimes naked; it is called *Coniomycetes.* The Fungi of this class are chiefly parasites and epiphytes, growing as specks and blotches—white, orange, brown, red, or black—on dead twigs and leaves. One of this family, the *Tilletia caries,* attacks the grains of wheat, which it turns black, and it gives them an offensive odour; flour made from the infected grain can only be used for gingerbread, as the condiments combined with it disguise the smell. The *Ustilago segetum,* another member of this family, attacks all cereals. The Red Cheese Mould belongs to the *Coniomycetes,* and has a fairer reputation.

The *Hyphomycetes,* or Thread Fungi, constitute the fourth family; they form beautiful objects under the microscope, but present merely black or coloured blotches to the naked eye. The Blue Mould of cheese is a popular member of this family; and the Potato Blight (*Peronospora Destructor*) is the most detested. It seems to spread through the whole plant, stem, leaves, and tubers. It consumes the starch, filling up the cells with its poisonous spawn. The mould familiar to us on jams, etc., is nearly allied to this. The spores of these plants are of amazing lightness, and float in the air in myriads, germinating when they find a suitable matrix. The Vinegar Plant has numerous barren threads which grow into a tangled mass. The Yeast Plant belongs to this group. Arising, like other Fungi, from spawn in the first instance, yet its spores multiply with such exceeding rapidity that it does not depend on the spawn for propagation: a simple cell placed in a congenial position buds in the course of an hour, and thus chains of cells are formed. These dried constitute the "German yeast." Hogg informs us that ringworm and another allied diseases are produced by a plant of this order; he also appears to be of opinion that such microscopic Fungi had a share in causing the cholera, great quantities having been detected in the air at the time when it raged. The mildew, so destructive to silk, gloves, etc., is of this group; another is found eating into the glass of our mirrors; and there is even one species which infests the chemical solution used in electrotyping. Some members of this group are able to bear any climate, from the heat of the Tropics to the cold of the Poles.

In the SPORIDIFEROUS group there are but two great families. The first, *Ascomycetes*, is characterised by the important distinction of the spores being enclosed in bags, or *asci;* the second, *Physomycetes*, are merely moulds.

Many members of the first group, the *Evellacei*, equal in stature and interest the aristocratic Agarics. The *Morchella esculenta*, or common morel, is much prized in Yorkshire, as giving excellent flavour to gravies, and no good housekeeper is without a string of them suspended in her store-room. Here the hymenium is in honeycomb cells on the upper surface of the cone; the stem is white and the head brown; they are found on field borders in May and June. So highly did the Germans appreciate its excellence, that they used to burn down a portion of forest every year, because the wood ashes secured a crop of morel; this custom was stopped by an edict of state. The *Helvellæ* have an even hymenium, drooping over the stem; there is an edible species, but I do not know its recommendations.

The *Mitrula paludosa*, with its white stem as thick as a *goose-quill*, and its orange club-shaped head, is a pretty ornament of peat-bogs in Yorkshire, while the *Leotia lubrica*, of similar form and olive colour, graces the Kentish hedgerows. But of all the wicked-looking Fungi, none have so weird an appearance as the black *Geoglossum.* It is well termed Earth-tongue, for it springs in a tongue shape from the ground, black and glutinous. I have seen it in cultivated plantations in Wilts, in woods in Herefordshire, and abundantly among the sward of Scottish heaths all about the Western Highlands. Contrasting agreeably with this, come the troop of brilliantly-coloured *Pezizæ.* Here the hymenium is *within* a cup—or sometimes saucer-shaped disk. The irregular cups of the large orange species (*P. aurantia*) grow in gardens and plantations in most counties. I have often seen them in Kent, and I remember them also in the cemetery at Glasgow. Many of the cups were as large as half a hen's egg, bright orange within and paler without. A round species, rough on the exterior and brown within and without, quite globular in youth and never fully expanding, is frequent in hotbeds; it is the *P. vesiculosa.* But the favourite of the family is the *P. coccinea*, adorning dead twigs of hazel with its scarlet cups, and forming with moss a charming winter bouquet. Children call it Fairy Bath. There are a great number of these *Pezizæ*, some larger even than the *Aurantia*, though not so brilliant in hue; and others smaller and yet more minute, till they become microscopic objects—lemon, white, blue, crimson, and green. The spawn of one of the latter colour imbues the wood on which it grows, and makes it very valuable for the workers in Tunbridge ware; it is the Verdigris Peziza.

The *Truffles* are members of this Ascomycetes class. The asci fill the inside of the plant, with the exception of branching partitions. They are subterranean in their habitat, and can only be found by means of a trained dog, who traces them by their powerful perfume.* They are famous in the annals of gastronomy, and Perigord pie owes much of its excellence to them. Under beech trees is their favourite position, and they are to be found in many districts of the South of England. Many species are sold in the Italian markets; one, with a garlic flavour, obtains as high a price as 9s. per pound.

The *Sphæriacei* are a very large group in this class, but most of them are microscopic objects. The *Cordiceps militaris* is one of the prettiest members. It has a distinct stem, and its head is club-shaped. Of the same genus is the *C. purpurea*—the famous Ergot, so deadly in its effects. It attacks all cereals, but more especially rye. Flour made of ergotted rye is so unwholesome that when in a time of famine some Norman peasants lived upon it, they were attacked with a very horrible form of gangrene, and died in great numbers. In the history of the faculty this poison is turned to good purposes, a valuable and potent medicine being extracted therefrom. It is likely that from this plant, or one of its allies, the famous Gipsy poison, the *drei*, is concocted. The Candle-snuff Fungus (*Xylaria hypoxilon*) is one of this group; its burnt-looking stems, crowned with white powder in youth, and afterwards swollen with the full asci, are familiar to us about tree stumps, etc. A few epiphytes, among which are the Hop, Rose, and Vine Mildews; a curious genus of minute Fungi infecting rotting horse-hoofs and cloth; and a series of true Moulds, as the Bread, Dung, and other Moulds, complete the group called *Hyphomycetes*, and conclude the list of British Fungi.

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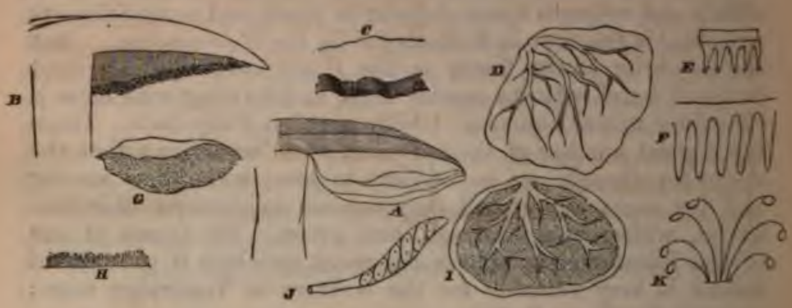
* See "Popular Science Review," No. IV. (Vol. I.), page 496, "The Common Truffle (*Tuber cibarium*), by Jabez Hogg, F.L.S., &c." (illustrated).



A. Agaric; B. Boletus; C. Polyporus; D. Merulius; E. Fistulina (*magnified*); F. Hydnum (*magnified*); G. Stereum; H. Hymenochæte; I. Tuber; J. Ascus; K. Jam Mould (*magnified*).

EXPLANATION OF PLATE XV.

HYMENOMYCETES.

Fig. 1.	Amanita muscarius .	Agarics, with hymenium disposed in lamellæ ...	Crimson.
Fig. 2.	Lepiota rachodes		Brown & white
Fig. 3.	Psalliota campestris ...		
Fig. 4.	Cantharellus cibarius...	Hymenium in veins......	Orange.
Fig. 5.	C. cornucopioides		Dark brown.
Fig. 6.	Boletus luteus	Hymenium in pores......	Yellow.
Fig. 7.	Merulius corium	Hymenium among veins	Shaded brown.
Fig. 8.	Clavaria fastigiata	Hymenium in the clubs	Yellow.
Fig. 10.	Tremella alba	Hymenium in the gelatinous substances	White.
Fig. 13.	Exidia glandulosa		Dark purple.

GASTEROMYCETES.

Fig. 12.	Cyathus striatus	Hymenium enclosed in a double or single envelope	Light brown.
Fig. 14.	Phallus impudicus ...		
Fig. 15.	Geaster fimbriatus......		Light brown.

ASCOMYCETES.

Fig. 9.	Geoglossum viscosum	Asci in clubs...............	Black.
Fig. 11.	Mitrula paludosa	Asci in the cup	Orange.
Fig. 16.	Peziza aurantia	Asci within the cup......	Orange.
Fig. 17.	P. coccinea...............		Scarlet.
Fig. 18.	P. versiformis		Green.
Fig. 19.	Xylaria hypoxilon	......Asci in the branches......	Black.

THE SKIN.

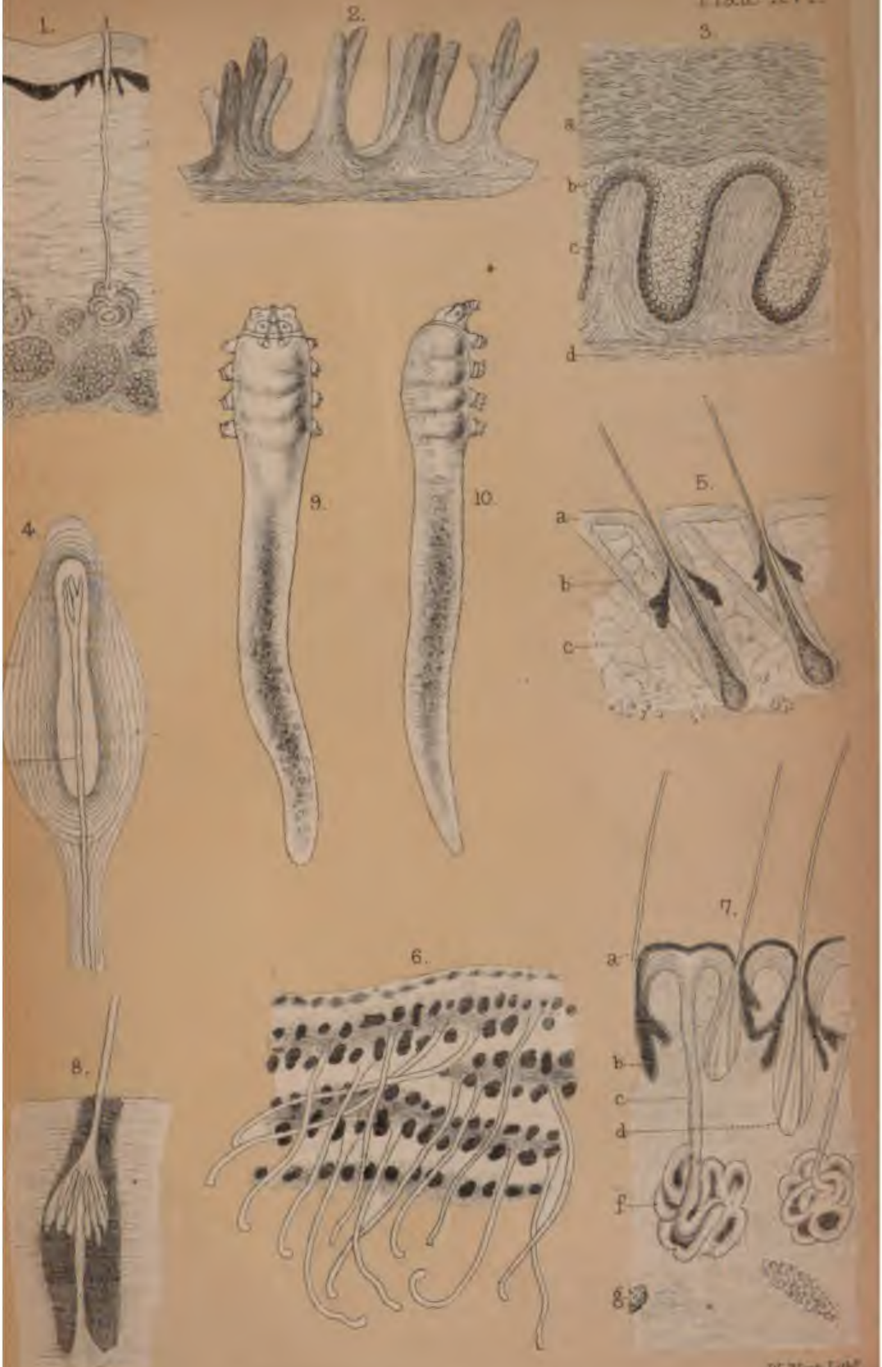
BY ISAAC ASHE, M.B., CH. M.

IT is a characteristic difference between the works of man and the works of the Creator that the former has to adopt many contrivances, and employ a cumbrous machinery, to bring about a single result, whereas the Creator generally accomplishes several ends by one and the same agent; and in few organs of the body, or in none, perhaps, is this more manifest, than in that one of which we are about to present to our readers a brief sketch.

We little think when we look at the Skin of our bodies, apparently so simple, what a wonderfully complex structure it really possesses, or how numerous, how varied and important, are the uses it serves in our animal economy.

Our readers would, perhaps, be startled to hear that our stomach, our liver, nay, even our brain itself, are less necessary to life than our skin. Yet it is well known that we may do without food, live without calling our stomach into action, for several days; that the liver also may wholly cease to act for several days before death ensues; and it has also been known that several monsters have been born without any brain whatever, which yet have survived for several days, discharging all the functions of organic life,—exercising motion, sucking at the breast like other infants, digesting their food, &c.,—and have continued so to do for a number of days greater than the number of hours it would be possible to survive were the functions of the skin completely stopped. The experiment has actually been made on the lower animals, and the results show that the skin is a most important auxiliary to the lungs in the process of aëration of the blood: and that if its functions be arrested, as has been done by varnishing the fur in a rabbit, or gilding the skin in a pig, the unfortunate animal dies in a couple of hours or so, with all the symptoms which would be produced by a slow cutting off of the supply of air to the lungs. On one occasion, before this fact was known, the experiment was unfortunately performed on a child, and with a like fatal result. This was on the occasion of the accession of Leo the Tenth to the Papal chair, when he gilded a child all over at Florence to represent the Golden Age; but the unfortunate child died in a few hours very unexpectedly, representing, we suppose, the short

Plate XVI.



Lankester del.

W. West, Lith.

Anatomy of the Human Skin.

duration of the age in question, and causing no little astonishment and speculation among philosophers, and probably no less superstitious feeling in the minds of the vulgar.

From these experiments we can easily infer how important a matter it must be to keep this organ constantly in an efficient state for the discharge of this as well as its other important functions. Indeed, this one organ the Creator has put specially into our charge, while all the other organs of our body are beyond our control. Yet often when we have neglected this charge, and suffer in consequence, we lay the blame upon organs wholly guiltless of our sufferings, such as the liver or stomach, which will work perfectly right without our care or attention, if we only give them fair play, and do not, by our neglect of the skin, throw upon them an amount of work twice as great as their proper share.

In insects, the entire respiration is conducted by means of pores in the skin, to which the name of *spiracles* is given, and of internal tubes called *tracheæ*, and they possess neither lungs nor gills. Hence arises the difficulty of drowning an insect in water; for as the pores are guarded by minute hairs, the water cannot enter them: but if a feather dipped in oil be applied to the abdominal portion of an insect's body, as to the yellow part of a wasp, it falls dead immediately; being, in fact, suffocated by the oil, which readily enters the pores in spite of the hairs, and so stops the respiration.

Aëration of the blood is not, however, the only function which the skin has to discharge; absorption is another, though not of equal importance. This is carried on by a system of vessels called the lymphatic vessels, which permeate the skin everywhere over the whole surface of the body. To illustrate this function, we may mention the fact, that persons in whom disease has closed up the natural entrance to the stomach by the throat have been kept alive for days and weeks by being frequently immersed in a warm milk bath. The late celebrated Duc de Pasquier, who died a short time ago at the age of ninety, had been kept alive for some weeks before his death by this means. Variôus salts, also, have been detected in the secretions of persons who have used baths containing those salts in solution, such salts having been taken up by the skin. Persons in distress for want of water at sea have also sometimes relieved their thirst by bathing the body in sea-water, so rapidly is absorption carried on under such circumstances.

Another and a most important function of the skin it discharges as the organ of the special sense of touch, which is only a highly exalted form of general sensation, which also resides specially in the skin. Under certain circumstances the reference of sensation to the part of the body touched becomes perverted; as in the case of a limb which has been removed, where, when the nerves that supplied the removed part are affected with pain, this is referred to the part which has been lost, it may be, years before.

The functions of the skin as a covering for the body, adding beauty and preserving the delicate structures underneath, regulating the intensity of sensations from without, and (by a beautiful contrivance which we shall subsequently refer to) the amount of temperature within, are a further illustration of the multiplicity of ends attained by the Creator through one and the same agency; and, though last, not least, we may mention the function of excretion, or removing from the body materials no longer of use to it, and which, if retained any longer, would become actually injurious to it.

We shall now proceed to describe the beautiful structure of the skin, by which it is adapted for the discharge of these numerous and important offices. The skin is composed, as most of our readers are aware, of two layers; an outer, called the *cuticle*, or scarf-skin, or sometimes termed the *epidermis*; and an inner, called the *cutis*, or true skin, or sometimes the *dermis*. This latter rests upon a very fine interlaced or netted structure, called the *areolar tissue*, out of which, if we may so express it, the granules and fibres of the skin are formed.

It has been usual to describe a third layer placed between the true skin and the scarf-skin, and called the *rete mucosum*, or pigment layer; but later researches have shown that there is no such distinct layer, and that the pigment cells, to which the colour of the skin in different races is due, are but a different stage in the development of the scarf-skin. This scarf-skin is never of very great thickness in any animal, but the true skin is of very variable thickness, and is that portion of the skin on which depends the thickness of the hide of the pachydermatous animals, a character so remarkable as to give name to the class to which they belong, which includes such animals as the rhinoceros, hippopotamus, elephant, horse, pig, etc. In the whale the cutis attains the thickness of about an inch, which is the greatest known in any animal.

It seems the most natural method in describing the skin to begin with the cuticle, which is at the surface, and so proceed from the better known to the less known, as in most other matters of knowledge. The cuticle, then, consists of several layers of laminated scales, the laminated form being best marked at the very surface, where the scales are constantly falling off as a kind of scurf, and are as constantly being renewed from below. These scales are formed by the flattening out of granules more or less rounded, which is the form assumed by the particles of the cuticle in its deeper layers; these granules are at first nucleated cells, and the colouring matter of the skin resides in the nuclei, and these granules it was that were formerly described as a separate layer under the name of the *rete mucosum*. They are very minute, being about 1-3000th of an inch in diameter at first; being renewed from below as the flattened scales are removed above, they gradually approach the surface, and as they do so they more and more lose the granular form and assume the scaly character, their diameter increasing accordingly to about 1-600th of an inch. In many animals, however, they are much larger than this, for the scales of reptiles and fish are indeed only a modified form of these epidermal scales in man; and in some of these creatures, as serpents, the epidermis, instead of being in a constant state of renewal and repair, as in man, is only removed at one particular season, when it comes off *en masse*, and is called the *slough* of the reptile. As may be supposed, the body of the animal is very tender after this process, and it goes off and hides itself for a season, until nature has repaired the loss of the old epidermis by a new one. Something similar to the gradual hardening of its new skin which then takes place we see in ourselves in the gradual hardening and thickening of a new nail, if we accidentally lose one, which we may observe to grow in thickness as well as in length. In fact, the nails are nothing more or less than modified cuticle placed in the position we find them in order to give protection and support to the ends of the fingers, and so enable the tips of the fingers, which are the tactile organs in man, duly to appreciate the nature of the bodies with which they come in contact; and it is found that the tactile sensibility of the finger is much impaired by the loss of the nail. In some of the lower animals the nails are further modified into claws, so as to become weapons of defence and offence.

Into the epidermis or cuticle no nerves or blood-vessels penetrate, and it is nourished merely by the transudation of the serum of the blood through the walls of the vessels of the true skin and subcutaneous areolar tissue; and as it has no nerves it is not itself sensitive, but on the contrary, serves to blunt the too exquisite sensation of the true skin. That it has no sensibility of its own may be proved when a small portion of it is detached from the underlying surface of the true skin, as by a blister; and this is the best way of demonstrating the cuticle in a living person, as it is extremely difficult to detach any portion of it by mechanical means.

Next we come to the structure of the cutis, or true skin, which is much more highly organized, and consists of two kinds of tissue, namely, white and yellow fibres; the former being denser and more resisting, and being therefore present in greater quantity wherever resistance is most needed, as in the palm of the hand and sole of the foot; while the yellow fibres are a highly elastic tissue, owing to their minute fibrillæ being arranged in interlacing curves, and these fibres cross each other repeatedly, and branch so as to form minute lozenge-shaped interstices, which are filled up principally by the white fibres. These yellow fibres, accordingly, as might be anticipated, exist in greater abundance where elasticity is a special requirement, as at the flexures of the joints, the lips, etc.

The uppermost surface of the cutis or true skin is strangely uneven and irregular, being elevated into a vast number of minute papillæ, which are about 1-100th of an inch in length, and 1-250th of an inch in diameter. Minute as these little papillæ are, each possesses a ramification of vascular capillaries and of nerve fibres; the latter, though not traceable to the very surface—being in fact the essential agents in the sense of touch, for that is the function of these papillæ,—they are the seat of the tactile power, and accordingly we find them developed in the greatest number and perfection where the tactile power is highest, as along the tips of the fingers and the lips in man, the lips specially in many quadrupeds, as the horse—these organs being the principal seats of the tactile power in them; also along the membranous expansion of the wings in bats, where the sense of touch and appreciation of impact are so delicate that the animal, even though blinded, can fly between suspended threads without touching them. These papillæ are also very well developed on the trunk of the elephant, the snout of the tapir, and at the roots of the hairs of the whiskers in the feline tribe, as well as on the under-surface of the prehensile tails of some of the monkey tribe, where the sense of touch is so delicate that they can ascertain by clasping it in their tails whether a nut has a sound kernel or not, and so save themselves a useless trouble and disappointment in cracking it if unsound. These papillæ are quite distinguishable on looking at the hand, for their extremities are received into depressions on the under-surface of the scarf-skin, and when this is stripped off and examined with a low power these pits or depressions are well seen, arranged in single or double rows, which correspond with the papillæ beneath, and above with the grooves or furrows which are visible on looking at the palm of the hand and inner surface of the fingers. These furrows are caused by the scarf-skin dipping in between the rows of papillæ, and all along each furrow at very minute intervals may be seen little cross lines which indicate the separations of the individual papillæ, or rather pairs of papillæ, for they are usually arranged in pairs. The number of these papillæ is immense; a square inch of the palm of the hand will contain more than forty rows, and each row more than sixty pairs, making in all about 5,000 individual papillæ in a single square inch of skin. They are not, however, equally well developed in all parts of the body, being nearly absent on the back, where, however, the cutis is tolerably dense, for there is no relation between its thickness and the development of these papillæ; on the tongue, for instance, the cutis is extremely thin, and yet the papillæ there are larger than in any other part of the body, and not that alone, but so thin also is the cuticle here that the individual papillæ are seen, giving that peculiar roughness to the tongue which is found to a certain degree in man, and to a very high degree in some of the lower animals, as the ox and the cat tribe.

Professor E. H. Weber instituted some delicate experiments on the sense of touch with the view of ascertaining its relative delicacy in different parts of the body, the method he adopted being to ascertain at what distance from each other two points of contact ceased to be perceived as one only, and were distinctly recognised as two. For this purpose he slightly blunted the points of a pair of compasses with sealing-wax and then applied them to different parts of the body. He then found that on the pulp or soft part of the tip of the fingers the points were perceived as two when separated only 1-36th part of an inch, while on the middle of the arm and thigh they had to be separated as much as 2½ inches. He also found, as might be expected, that they were more readily perceived as two when placed across the direction of the branches of the nerves than when placed parallel to their branches. A well-known fact is that the sensations of heat and cold, which of course appertain to the sense of touch, are to a certain degree relative; that is to say, that if we place one hand in warm water and the other in cold, and then plunge both into a vessel containing water at an intermediate temperature, this will appear hot to the hand which has been in the cold water and cold to the other. Weber has also shown a very curious fact, namely, that if both hands are plunged into water of the same temperature without previous preparation it will seem warmer to the left hand than to the right. To obtain an accurate result this experiment ought to be performed with the eyes blinded, and in ignorance of the relative temperature of the water in the two vessels, so as to remove the influence of reason or imagination. Some other curious phenomena regarding the sense of touch have also been found to exist, such as that if two of the fingers be crossed and then a single small object, as a pea, be placed between them, the mind will appreciate it as two objects; or, again, that if two points, as of a pair of compasses, be applied to the skin at a fixed distance, they will feel as if more widely separated when on a very sensitive part than they will elsewhere, or if drawn along the skin from a less to a more sensitive part will seem to separate as they approach the latter; and, again, that a perfectly plane or level surface may be made to appear concave by another person drawing it over the tip of the finger of one whose eyes are covered, and pressing at first strongly, then lightly, and then strongly again, or it may be made to appear convex by reversing this order of pressure; but if the pressure is regulated by the subject of the experiment himself the delusion vanishes. Indeed, all these experiments ought to be performed on a person whose eyes are blinded, and by a second party.

The extreme delicacy to which the sense of touch may be brought by practice often receives curious illustrations. One of the best known is the ability of the blind to read raised letters; and in one case, when the sense of touch of the pulp of the fingers had been much reduced by injury, the sufferer learned to read by applying her lips to the letters. It is said that in counting rapidly a roll of bank-notes, a clerk in the Bank of England will be able to detect a counterfeit note by the touch alone, which no examination by an ordinary individual could distinguish from a genuine note, even were he aware that it was forged.

Such are some of the wonders of the sense of touch,—a sense whose impressions are conveyed to the mind by nerves set apart for that office, these nerves being the posterior roots of the spinal nerves, and the fifth and eighth cranial nerves. The fifth cranial is, indeed, a very singular nerve; for, besides having motor fibres as well as sensitive, it has some of its sensitive fibres so modified, that in the papillæ of the tongue they become the nerves of the special sense of taste; and indeed, in some of the invertebrate animals, as the crustaceans, this nerve also receives the impressions of the special senses of sight and hearing.

We come now to the function of secretion, and the description of the beautiful and complex apparatus by which that function is carried on. When we look with a simple lens, or even with the naked eye, at the delicate grooves crossing the furrows of the hand above mentioned, we find that a small orifice exists in the centre of each of them, sometimes occupying nearly the whole of the groove. This is, in fact, the orifice of a perspiratory duct; and when the hand is warm the perspiration may be observed, even with the naked eye, to issue from it, forming minute shining dots. The glands by which the perspiration is secreted are seated at the under-surface of the true skin, each embedded in a cavity in it; and they consist, like many other glands, of a ravelled tube formed of basement membrane and epithelial scales, together with true secreting structure; the materials for secretion being furnished by a minute capillary network of blood-vessels arising from arterial trunks, which bring the blood to the gland to be purified, and terminating in venous trunks, which carry off the blood when that process has been performed.

These glands are consequently to be regarded as true excretory organs, removing from the blood materials that are no longer wanted, and which, if retained, would be injurious. Their size varies in different situations, being in the palm of the hand from 1-100th to 1-200th of an inch in diameter, but in the armpits, where they are largest, and form a very thick layer, they reach the size of 1-60th of an inch. Their ducts are composed of basement membrane and epithelium only; the latter being an inflection from the scarf skin which runs down the wall of the duct. The length of the tube which constitutes both gland and duct is about a quarter of an inch. It is straight while passing through the true skin; but becomes strongly spiral while traversing the scarf-skin, the turns being as close and regular as those of a screw. The diameter of this tube is about 1-1700th of an inch. We can have little idea of the importance of these little ducts to the system from considering any single one of them; but when we come to consider them collectively, we may in some degree estimate their value, and the necessity of maintaining their functions in healthy action. Over 3,500 of these little ducts have been found to exist in a single square inch of the skin of the palm; and accordingly, taking the length of each at a quarter of an inch, as we mentioned above, we find that their aggregate length amounts to 73 feet. On a square inch of the heel the length would be about 47 feet. About 60 feet would represent the average length of these ducts for a single square inch of skin for the whole body; and as the number of square inches in a person of ordinary size is about 2,500, we arrive by computation at the startling result, that the aggregate length of the sudoriferous ducts of the body is about 28 miles.

It was to this glandular system we referred, when we said there was a beautiful contrivance for regulating the internal temperature of the body; for the perspiration so poured out is vaporised principally by the heat of the body; and in thus turning into vapour it renders latent, as all liquids do in undergoing that change, an enormous amount of heat, which is thus being constantly carried away from the body as fast as it is generated by the chemical processes constantly going on within the system. Hence we see the cause of that burning heat of skin which is so marked a symptom of some diseases when the perspiration is completely arrested, causing that peculiar harsh, dry skin, which is so well known to the physician as the concomitant of this burning heat.

It is due to the same cause that the blood never exceeds about

98° Fahr. in temperature, even under violent exercise; for a copious flow of perspiration carries off the heat so generated. And for the same reason it is possible in dry air to bear with impunity a degree of heat much beyond what could be borne in moist air, where the perspiration would not be vaporised as fast as excreted. Water, at the temperature of 120° is almost unbearable. A vapour bath at the same temperature might be endured for a few minutes; but the distress arising from the suppressed perspiration would soon render it intolerable. But in dry air a heat can be borne with impunity, and almost without discomfort, which will roast eggs and dress beafsteaks. In some experiments performed by Drs. Watson and Carpenter, it became desirable to ascertain the height at which a thermometer stood in an oven, without subjecting it to the cooling consequent on withdrawing it. A girl volunteered to go into the oven and mark the height of the mercury. The gentlemen hesitated at her proposal; but she assured them she was not in the least afraid of so doing; and she actually went in, and remained there for ten minutes, while the thermometer stood at 280°; and another girl remained for five minutes in the oven with the thermometer at 325°, or 113° above the point of boiling water. Beefsteaks were cooked in this oven, merely by the temperature of the air, in thirty-three minutes; and when the air was blown on them by a pair of bellows, they were cooked in thirteen minutes. And yet in these experiments the young women suffered scarcely any inconvenience; and the heat of the body, as tried by a thermometer placed under the tongue, was scarcely at all increased. Sir Charles Blagden remained for some minutes in air of about the same temperature, and also Dr. Lankester; and Chabert, the French showman, called the Fire King, was in the habit of entering an oven heated from 400° to 600°, or within a few degrees of the heat of molten lead. Animals covered with hair or feathers, however, die very soon in temperatures much below these; apparently because the hair or feathers interfere with the free escape of moisture from the skin, which is necessary to keep the blood cool, and prevent injurious consequences. Hence, also, persons who are in the habit of taking Turkish baths, which are, in fact, hot-air baths, experience no inconvenience from the high temperature as soon as the perspiration begins to flow, which, in a practised bather, it does immediately.

The amount of liquid which, in a person in health, issues from the pores during the twenty-four hours is not less than an imperial pint, containing about an ounce of solid matter in solution, and besides a large amount of carbonic acid gas: hence we can estimate the importance of keeping these ducts in perfect order by means of frequent bathing.

Another kind of gland is also found in the skin in connection with the hairs, and engaged in their nutrition. These glands are called the sebaceous glands, inasmuch as they furnish an oily or waxy substance to nourish the hairs; this substance is developed in largest quantity inside the ear, where it serves to prevent access of dust, insects, &c., to that delicate organ. The ducts of these glands are not spiral, and they open generally into the hair follicles, or pits which the hair grows out of, situated in the subcutaneous areolar tissue.

There are generally several glands connected with each hair; their ducts are frequently inhabited by a very peculiar little parasite, by no means a beautiful object when viewed under the microscope, but found even in the cleanest and healthiest persons, sometimes three or four being in each follicle; yet they are specially found in persons whose skin is torpid in its action, and they multiply in sickness. These glands lubricate the skin, and so maintain its elasticity, and they also serve to eliminate hydrocarbons from the system; they are extremely numerous, as may be inferred from their connection with the hairs.

We may here mention briefly the structure of hair, as being connected with these follicles. Hair may be regarded as a kind of modified cuticle, though it takes its origin much deeper than the cuticle, and even deeper than the true skin. The scales of the epidermis descend into the hair follicle, forming its lining, and then, at the bottom of the follicle, the cells which on the surface would become cuticular scales are changed into a layer of imbricated or overlapping scales, which form the cortex or bark of the hair; while the cells which grow from the very bottom of the follicle are modified into elongated fibres, and so form the inner substance of the hair.

A very curious and beautiful structure is especially developed around the hair follicles and sebiparous glands, consisting of minute, quite microscopical muscular fibres, not capable of being acted on by the will, but acting involuntarily on the application of certain stimulants, external or mental; cold, fear, anger, &c., will stimulate these fibres to contraction, and hence, owing to their peculiar interlacing around the hair follicles, arises the peculiar bristling so well seen in some animals, particularly the lion and others of the cat tribe, under the influence of these emotions. To this cause also is due what is known as the hair standing on end, the first notice of which we have in the Book of Job—"Then a spirit passed before my face; the hair of my flesh stood up." The creeping of the flesh under the same emotions is due to the same cause; for, although particularly well developed around the hair follicles, these muscular fibres are not confined to them, but extend everywhere through the skin, and the appearance assumed by the skin under the influence of cold, and known as the "goose-skin," is due also to their contraction.

Hair is almost universally the covering of the skin in the class of Mammalia, and is found even in the whale, but only in the shape of a few scattered hairs here and there over the body, so that it can be of no use except to carry out the type of the organisation of the class. In certain parts of the bodies of some animals hairs sometimes become remarkably developed and strangely modified, as is the case in the hedgehog and porcupine, where they assume over the greater part, but not the whole of the body, the form of spines and quills.

In the class of birds hair is not found, being replaced by feathers, and the apparent hairs on animals of this class, on being examined with a microscope, present the characters of feathers, and not those of hair.

We have thus sketched the principal characters of that beautiful organ, the Skin, which, it is hardly necessary to observe, is as completely illustrative of the Creator's skill and wisdom as is every other portion of the animal frame.

EXPLANATION OF PLATE XVI.

Fig. 1. Vertical section through skin of thumb.
  a. Horny layer of epidermis; b, its mucous layer; c, the corium; d, fat globules; e, sudoriparous glands; f, their canals; i, sweat-pores.

Fig. 2. Compound papillæ, from the hand.

Fig. 3. Section through the skin, from the leg of a negro; a, horny layer of epidermis; b, mucous layer; c, coloured cells of the mucous layer; d, papillæ.

Fig. 4. Termination of a nerve in a Pacinian corpuscle, from the hand; A, nerve; B, envelope.

Fig. 5. Perpendicular section through the scalp, with two hair-sacs; a, epidermis; b, muscle of the hair-follicle; c, cutis.

Fig. 6. Under-surface of the epidermis, from the palm, showing the depressions in which the papillæ were lodged, and the sudoriparous ducts attached.

Fig. 7. Section through the skin, near the ear. a, horny layer of epidermis; b, sebaceous glands; c, canal of; f, ceruminous glands; d, hair follicle; g, fat globules.

Fig. 8. Hair-sac, from the face, with several specimens of *Demodex folliculorum* attached.

Figs. 9, 10. *Demodex folliculorum.*

Figs. 1—7 are after Kolliker (Hum. Hist.)
Figs. 8—10. E. Wilson, in Proceedings of Royal Society.

THE FURNITURE WOODS OF COMMERCE.

BY P. L. SIMMONDS.

THE commerce in Foreign Woods carried on by this country is much larger than would be supposed by those who had not looked into the figures; and the vast quantities of timber, useful and ornamental, received, form a very interesting subject of inquiry. The timber of many countries is a most important item in its annual income, especially in Russia, Austria, Norway, Switzerland, Brazil, and also in British North America, India, Guiana, and some other of our possessions. The value of the woods of all kinds that we import is not less than twelve millions sterling, whilst about four millions more may be set down as the value of the home produce. These woods, as far as their economic uses are concerned, are divided into three classes:—

1st.—Woods of construction, useful for ship and house building and other rough work.
2ndly.—Those suitable for cabinet and ornamental work, as tables and other articles of furniture, pianofortes, &c.
3rdly.—Dye-woods, and many hard woods, used chiefly by the turner, carver, engraver, &c.

To the first class belong such woods as the fir, and indeed all the Coniferæ, if we except the evergreen cypress, whose beautiful colour and pleasing odour fit it in an especial manner to rank among the higher class of cabinet woods. To this division belong also the beech, ash, chestnut, poplar, and willow; while teak, oak, and plane-tree would seem to occupy a middle class, connecting this with the second, or more ornamental woods, among which are ranked mahogany, rosewood, walnut, maple, laburnum, mountain ash, box, &c.

It is to the Furniture Woods that we purpose confining our present observations, and chiefly to those received from foreign countries.

The importance of this survey will be better appreciated when it is stated that the annual value of the household furniture made in this country alone was, more than ten years ago, estimated at fifteen millions, and has certainly largely increased since then, keeping pace with the wealth and numerous wants of the nation, and progress of commerce. The computed value of the rough fancy hard woods imported in 1861 was £804,426, to which has to be added household furniture and cabinet-ware, valued by the importers at £32,557; 769 pianofortes, of the declared value of £24,542; besides other items. This, then, forms the aggregate trade in which we are specially interested, quite exclusive of the large commercial trade in rough woods and furniture carried on by other European nations.

The foreign fancy and hard woods specifically enumerated in the official trade returns are very few, being only mahogany, rosewood, maple, satin, walnut, ebony, and cedar, besides a few such as box, barwood and camwood, brazilleto, &c., which are chiefly used for other purposes. There are, however, some very beautiful woods which, being scarce, are imported in but small quantities.

Oak, ash, elm, beech, birch, &c., are designated *hard woods;* whilst mahogany, rosewood, zebra, tulip, kingwood, satin, and other furniture woods, are usually sold under the denomination of *fancy woods.* From the most common description of pine to the finest variety of satin-wood or calamander, from mahogany to walnut, from wainscot to ebony—all are in some way or other made to do service in their respective places for the cabinet-maker.

The elements of beauty in wood may be considered as consisting in lustre, figure, and colour; in the degree of which there are, however, numerous modifications as well as limitations.

The medullary plates contribute essentially to the character of ornamental woods, not only from being the secondary cause of the lustre of most of those woods that are remarkable for this quality, but likewise by their own inherent properties. In nearly all the coloured woods the colour of the medullary plates is much deeper than that of the fibres, sometimes varying even in kind, so that when viewed in different lights they present different colours. The plane or sycamore is remarkable for the size and distinctness of its medullary plates, these being of a rich chestnut brown, with a considerable lustre, while the fibres are nearly white and almost dull.

There is another source of variety in wood, both in figure and colour, depending on the comparison and contrast of one annual layer with another. Much irregularity takes place in this respect. But this very irregularity is a source of beauty, and is capable of being indefinitely varied by making the section more or less oblique to the axis of the tree. An alternation of colour not unfrequently accompanies these concentric rings, but is not indicative of any change of structure; and when the colours are lively, well defined, and well contrasted, their effect is very agreeable: kingwood, tulip-wood, Amboyna wood, yew, lignum vitæ, and partridge-wood, are perhaps some of the most remarkable.

This symmetrical distribution of colour passes by insensible degrees into the striped, the veined, and the mottled, of which walnut affords the best example among the more common woods; and spotted and veined ebony, rosewood, zebra wood, and Coromandel wood, among the more valuable ones. The three latter are particularly beautiful, especially the Coromandel wood, whether we regard the harmonious tone of its colours, passing from brownish white to rich chocolate, or nearly black, or the broad masses in which these are arranged, giving it more the appearance of brecciated marble than of wood.

One other variety in the figure of woods is the occurrence of eyes, zoned spots and small curls, of which the bird's-eye maple, amboyna wood, and the root or burr of the yew and the common maple are the most beautiful. The knobby tubercles that form on the root and trunk of the common elm, from repeatedly stripping off the side branches, afford a very beautiful wood called "curled elm."

We will pass on now to notice the principal woods, giving prominence to Mahogany as being that most largely used.

In 1820, when the duty on mahogany was £11 17s. 6d. the ton, the imports were 16,005 tons; in 1830 nearly the same, although the duty had been reduced in 1826 to £7 the ton. In 1850 the imports were 33,650 tons; and in 1861, 53,108 tons, valued at £569,000. Mahogany unquestionably occupies the highest rank in the scale of furniture woods; it has long continued in steadily increasing request for all kinds of cabinet work, ornaments in wood, and generally for all purposes to which timber is applied for interior decoration. A thousand pounds has frequently been given for a good log of mahogany —and few probably of the visitors at the International Exhibition gave a second glance at the huge squared log of mahogany, which was shown in the Haytian Court, worth many hundreds of pounds, or reflected upon what might be its ultimate destination when sawn or cut into veneers. The principal sources of supply for this wood are Belize, British Honduras, which furnishes one half, St. Domingo, Cuba, and Mexico.

Spanish mahogany imported from Cuba, Hayti, and other West India islands, is in smaller logs than the Honduras, seldom exceeding sixteen to twenty-four inches square, and from six to twelve feet long. The colour is paler, the lustre less, in consequence of the medullary plates being smaller and irregularly distributed; the grain is also finer than the Honduras, and the texture harder. Many of the more expensive woods are cut into thin strips, termed veneers, which are glued on to pine surfaces, or other common woods, and by this process nine-tenths of the wood are saved.

By the use of beautifully adapted circular saws, worked by machinery, veneers are often cut of the thickness of one-fortieth of an inch, a little thicker than the sheet of paper on which this is printed. By the largest saws, logs of mahogany, three feet square, can be cut up into unbroken sheets of veneer at the rate of about ten or twelve to the inch, and so beautifully smooth as to require scarcely any dressing. The longitudinal edges of the veneers are protected by a calico band glued on, to prevent them from splitting when removed. Walnut is cut, not in longitudinal sections like other veneers, but in thin spiral sheets from the circumference of the tree. That makes the thinnest veneer of the whole, but it is frequently defective.

Rosewood, obtained from Brazil, and walnut, from Belgium and Italy, are probably, next to mahogany, the most important furniture woods.

There is still great confusion as to the trees which furnish the South American rosewood. From the Portuguese name of Jacaranda, the scientific name of *Jacaranda Brasiliana* has been applied to it. There is, however, little doubt that several species of *Tri[illegible]* yield rosewood in the province of Bahia.

The demand for rosewood has lately fallen off; for while in 1854, 5,670 tons, of the value of £82,211, were imported, on the average of the three years ending 1861 the imports were only 2,000 tons.

Rosewood exhibits large elongated zones of black irregular lines on a reddish brown ground, of various tints and high lustre. The grain varies,—being frequently very coarse, but in selected specimens sufficiently fine for the best description of furniture. The dark colour in general is too predominant; but when this is not the case, and the lighter ground is disposed in larger masses than usual, the wood is considered very beautiful.

Some of the specimens of Maple wood from North America are very ornamental, especially those of the red-flowering maple ([illegible]), and the sugar maple (*A. saccharinum*).

It sometimes happens that in very old trees of the former species, the grain, instead of following a perpendicular direction, is undulated; and this variety bears the name of "curled maple." This singular arrangement, for which no cause has ever been assigned, is never witnessed in young trees, nor in the branches of such as exhibit it in the trunk. It is also less conspicuous at the centre than near the circumference. Trees offering this disposition are rare, and do not exist in the proportion of one to a hundred. The serpentine direction of the fibre, which renders them difficult to split and to work, pro- [illegible] in the hands of a skilful mechanic, the most beautiful [illegible] of light and shade. These effects are rendered more [illegible] after smoothing the surface of the wood with a double-ironed plane, it is rubbed with a little sulphuric acid, and then with linseed oil. On examining it attentively, the varying shades are found to be owing entirely to the inflection of the rays of light, and this is more sensibly perceived in viewing it in different directions by candle-light.

Before mahogany came into such general use, the wood of the red-flowering maple was largely employed in America for furniture; bedsteads are still made of it, which in richness and lustre excel the finest mahogany. Veneers of it are much used to inlay other woods in articles of cabinet work and for the finishing of ships' cabins. The red-flowering maple never produces the variety known as "bird's-eye maple," that being confined exclusively to the sugar, or rock maple. The sugar maple exhibits two accidental forms in the arrangement of the fibre, of which cabinet-makers take advantage for making beautiful articles of furniture. The first consists in undulations like those of the red-flowering maple, and is likewise known as "curled maple;" the second, which takes place only in old trees which are still sound, appears to arise from an inflection of the fibre from the circumference towards the centre, producing spots of half a line in diameter, sometimes contiguous, and sometimes several lines apart. The more numerous the spots, the more beautiful and the more esteemed is the wood. This variety is called "bird's-eye maple."

Maple is now imported in considerable quantities from New Brunswick, and fetches a high price; 413 tons, valued at £2,752, were received in 1861. The ancients held the maple in great esteem, and tables inlaid with curious portions of it, or formed entirely of its finely variegated wood, in some instances realized their weight in gold.

The principal portion of the Satin-wood that comes into commerce is brought from the West Indies, and is produced by *Maba Guineensis*, an ebenaceous tree in the Bahamas, Hayti, &c.

It is of a beautiful deep yellow colour, mixed more or less with orange and brown, and hence called, locally, "yellow wood;" is remarkably close-grained, heavy, and durable. It is sometimes confounded with East Indian satin-wood, the produce of *Chloroxylon Swietenia*, a cedrelaceous tree. The latter possesses the richest colour, whilst the West Indian satin-wood has a higher and more variable lustre. In some instances the Indian wood is beautifully patterned or flowered, and is much used for picture-frames, rivalling bird's-eye maple. Indeed, satin-wood fetches a much higher price than maple. The Chinese are very partial to this wood, and receive quantities of it from Siam. We obtain some from Ceylon and Madras.

Our supplies of the dark blackwood, known as Ebony, to the extent of 1,500 tons, are imported chiefly from the west coast of Africa, Madagascar, India, and Ceylon. It is the duramen or heart-wood of several species of *Diospyros*, and is much used for inlaying work by cabinet-makers.

Previous to the introduction of mahogany, rosewood, and other exotic woods, that of the Walnut was held in higher estimation than that of any other European tree, and supplied their places in the manufacture of the most valuable and costly pieces of furniture, examples of which are still to be seen in houses of ancient date, whose beauty in grain, polish, and pattern, would bear comparison with any of the choicest woods of the present day. Indeed, of late years we have been returning to this taste; for while foreigners prefer mahogany for cabinet work, we have taken again to walnut for suites of furniture. The imports of walnut-wood have recently averaged 3,200 tons, or double the quantity of rosewood imported.

The name Cedar is given to several woods, but properly belongs to the almost incorruptible wood obtained from two species of *Cedrus*,—*C. Deodara* and *C. Libani*. This is the cedar spoken of in Scripture: "The cedar of the house within was carved with knops and open flowers: all was cedar; there was no stone seen."—(1 Kings, vi. 18.)

The wood of the common *Cedrus* is far less valuable. The cedar chiefly imported is *Cedrela odorata*, in logs, free from knots and straight-grained, from Cuba, Mexico, and Central America, in quantities varying from 3,000 to 5,000 tons yearly. Thirty years ago the consumption was less than half that quantity. The red or pencil cedar of Virginia (*Juniperus Virginiana*) is also imported, being serviceable for internal joiner's work. The rare beauty of the sideboard top of Australian cedar root in the New South Wales court of the late Exhibition attracted much attention.

Oak still retains its time-honoured place in Gothic furniture and libraries. Wainscot oak is imported in logs from the Baltic, for cutting into planks or slabs for furniture, or for panelling rooms.

Having noticed the principal woods imported in quantity, we may now incidentally glance briefly at a few others deserving of mention. And here it may be remarked that nearly all the ornamental woods used are derived from tropical countries, although occasionally specimens of woods grown in temperate regions are characterised by considerable beauty. Thus the curled ash of Canada, from the beauty of the figure, if better known, would be much appreciated by our timber merchants, the pattern resembling the renowned Hungarian ash, a wood which was in great favour here at one time, and realized a high price, but could not be obtained in large planks.

The Laburnum has a wood of a darkly variegated colour, rendered more beautiful by a lustre of metallic green, and when knotted is equal to mahogany. The medullary plates, which are large and very distinct, are white, and the fibres of a dark brown, a circumstance that gives quite an extraordinary appearance—a peculiarity not to be observed in any other wood.

Incidental mention has already been made in the Notes on the Exhibition,* of some of the fine woods of our colonies; but as yet scant justice has been done to them in the way of publicity, either in the Jury Reports or through any other medium. Such a magnificent collection of woods of all kinds, many of them new and rare, from different countries, was never before brought together, and it is very doubtful if it ever may be again.

Many of these woods are as yet comparatively unknown; the difficulties in the want of labour, proper roads, and available means of transport, have hitherto prevented the various treasures of our colonial forests from becoming readily accessible to the requirements of our artizans.

Numerous illustrations were afforded of the suitability of many of these woods for furniture, for smaller articles of turnery and ornamental workmanship, and for parti-coloured work in marquetry, wood mosaic or Tunbridge ware, and Sorrento inlaying. Innumerable specimens of cabinet-work, of the highest excellence, were seen to great advantage, and obtained universal commendation from competent judges.

Many of these elegant pieces of ornamental work displayed the peculiar beauty and figure, the closeness of grain, and, in some cases, revealed the fragrant odours of the smaller woods, and showed how well they are deserving of more extensive notice than they have hitherto received. Many of the woods exhibit a peculiar beauty of structure; some are highly fragrant, and retain their agreeable odour for a considerable period of time, which renders them additionally pleasant and acceptable in the form of ornamented articles to the boudoir and drawing-room.

Some of the rarest and most esteemed ornamental woods are South American, and come chiefly from Brazil; among these are tulip-wood, zebra-wood, the produce of *Omphalobium Lamberti*, king-wood, canary-wood, partridge and pheasant wood, and purple-wood.

Coromandel or Calamander wood is the produce of an ebenaceous tree of Ceylon, and considered, from its peculiar marking, one of the handsomest of the brown woods. It is getting scarce. Kingwood and zebra-wood are rich yellowish-brown, striped; sometimes full of zoned eyes.

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* "Popular Science Review," No. VI.—"The Colonies," &c.

A valuable, heavy furniture wood of British India is the blackwood, locally called rosewood, obtained from the *Dalbergia latifolia*, a leguminous tree. It can be procured in any quantity, and of immense size, but in large panels is liable to split. Jackwood (*Artocarpus integrifolia*) furnishes a yellowish wood, which deepens into brown. When made into tables and well kept, it attains a polish little inferior to mahogany. The Chittagong wood (*Chickrassia tabularis*) is more used in Madras for the making of furniture than any other wood. It is light, cheap, and durable.

Lingoa wood, the Amboyna wood of commerce, was imported into this country in considerable quantities from the Moluccas during the time those islands were British possessions. It is stated to be abundant at Ceram, New Guinea, and throughout the Molucca seas. The wood can be obtained in any quantity if the precaution be taken of ordering it during the previous season. Circular slabs of Amboyna wood are occasionally met with as large as nine feet in diameter; but the usual size is from four to six feet. These slabs are obtained by taking advantage of the spurs which project from the base of the trunk, as the tree itself has not sufficient diameter to furnish such wide slabs. The kayubuka of commerce, so much esteemed as a fancy wood, is obtained from the gnarled excrescences which are found on these trees (*Pterospermum Indicum*).

In the beauty of its duramen the blackwood of Australia (*Acacia melanoxylon*), also known as lightwood, possesses many resemblances to the best walnut, and is considered even superior to that wood, being harder and more durable. It is a favourite wood with the cabinet-makers of Victoria for furniture of every description, and receives a very high and beautiful polish.

There is one other very ornamental wood which has lately been largely used in cabinet work by the French,—the cypress of Algeria (*T*[illegible]). The wood is dark nut-brown, close-grained, and very fragrant. It is believed to be the *algum* or *almug* of Scripture, one of the most costly materials furnished by Hiram, king of Tyre, to Solomon, for the building of the Temple, and for the house of Mount Lebanon. Planks of this wood formed the precious citrine tables of the Roman banqueting halls.

It requires a large capital to keep up a good stock of seasoned wood, so as even to support a moderately large manufactory; but as there are no duties on wood, it pays the dealer well to lay in a stock of furniture wood for seasoning, because the unexampled prosperity of our colonies insures for a long series of years a market for the furniture of Europe. Nothing but the taste and make of the mother country will suit her colonists, and skilled labour is too high in the colonies for much attention to be given yet to furniture and cabinet-making. The value of the furniture, cabinet, and upholstery wares annually exported from the United Kingdom averages from £250,000 to £350,000.

There was a time, we are told by a leading Liverpool timber firm, when a portion of the capital of that county (Lancashire) employed its population in the manufacture, and its merchants in the exportation of furniture. The foundations of the fortunes of the more prosperous cabinet-makers and shipowners were so laid. Circumstances, however, interrupted this state of things, through the imposition of war duties of £12. 10s. per ton on Spanish mahogany, and £45 per ton on rosewood; and Lancashire ceased to employ its people in the manufacture beyond the home trade, and its merchants ceased to load the 'tween decks of their ships with furniture to the colonies.

FOSSIL BIRDS.

BY S. J. MACKIE, F.G.S. (EDITOR OF "THE GEOLOGIST.")

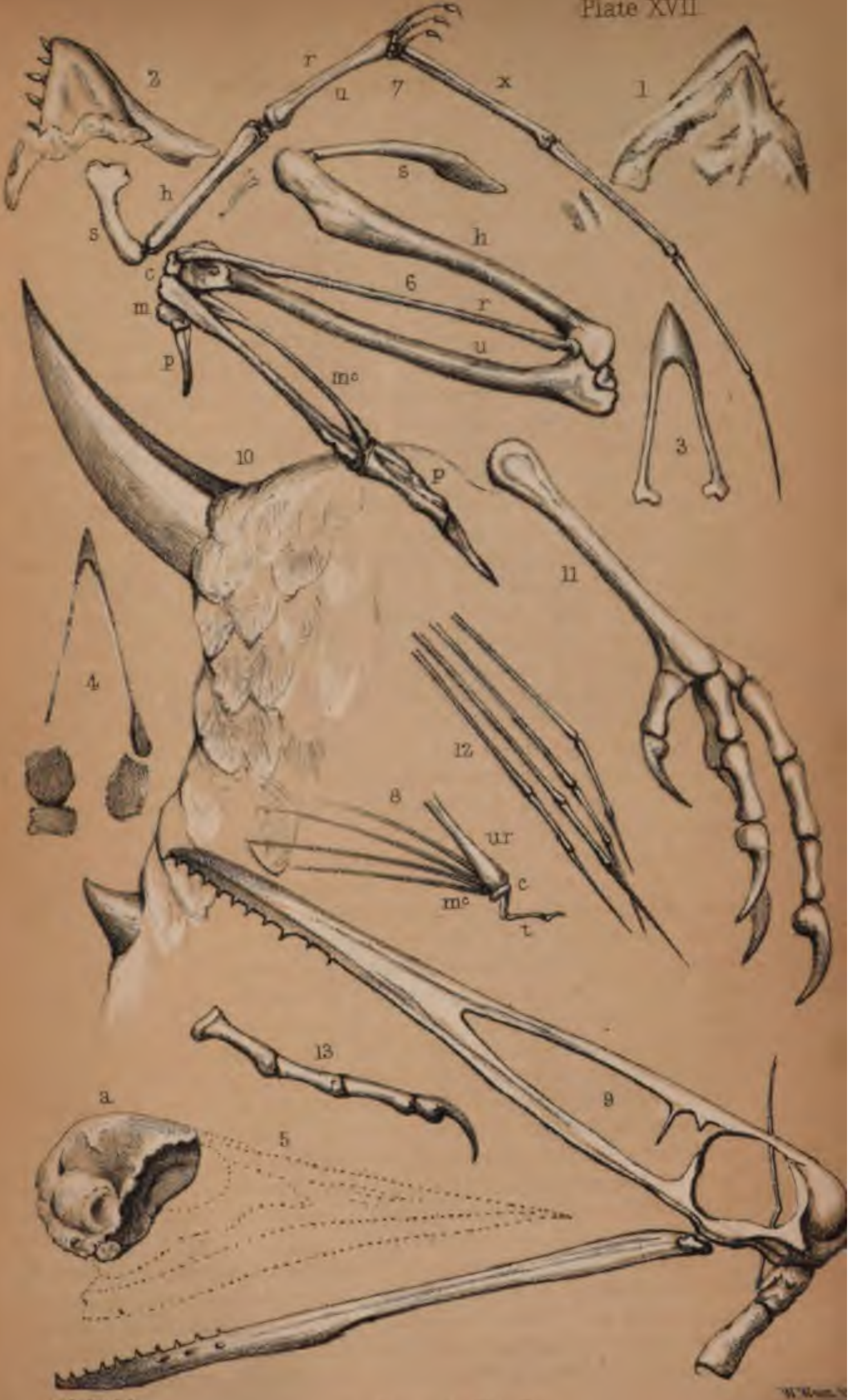
OF all the wonderful applications of vital force as a mechanical power to the locomotion of solid bodies, that of flight is the most marvellous; and delighted as we are with the cheerful voices and painted plumage of birds, their graceful and rapid motions through the air equally attract our attention.

In the far past exhibited by Geology, we look back to a pristine age of shell-fish and "creeping things." Then follow fishes, smoothly gliding through the sea—nicely-balanced aquatic balloons that rise and fall by voluntary compression or expansion, and propel themselves by the strokes of side-paddles or the lateral lashings of a rudder-like tail. Next, amphibious life—great reptiles basking in the sea, and sluggishly crawling over the muddy shores. Then, an age of mammals browsing herbivores, fierce carnivora, flat-footed bears, ponderous elephants, fleet deer and horses—walking on four props or legs on the firm land. Now we see four-handed beasts swinging with easy agility from bough to bough, and tree to tree vegetarian inhabitants of the woods—and two-footed, two-handed man walking erect, and master of the earth.

From the earliest records of the earth's history that we possess, the idea of *flight* seems absent; and it is not until we have passed the vast Palæozoic age, and entered the secondary epoch of the earth's crust-formation, that we find any trace of this idea. Then, indeed, we find foot-prints of perhaps wingless, or nearly wingless, birds; but scarce a bony relic of all the thousands that trampled on the yielding shore, and left "their foot-prints on the sands of time." The first of birds, so far as we can learn from their foot-prints, were cursorial—runners like the ostrich, or rather like the rhea. We have no evidence to show they could accomplish long or lofty flights; but, on the contrary, all the little that we know seems to prove that their wings were rudimentary, and only assistant to their velocity of pedal progression.

Then follows a long silence, broken, as it were, by whispers, and a few decisive words—a few bones, here and there, in the cretaceous and oolitic beds—and then the wonderful Archæopteryx. But during this long silence *flight* was a prominent [illegible] of animal motion; and that, too, in perhaps its most

Plate XVII.



A. Mackie lith.

Fossil Birds.

W. West

singular phase. Astonishing in their vast proportions as are the fossil reptiles of the Jurassic ages displayed in gigantic models in the pleasure-grounds of Sydenham, still more astonishing are other reptilian relics of those marvellous times. Then it was that reptiles *flew*. Sluggish as are now presented to us the cold-blooded crocodile, frog, and turtle, reptiles then spread an expanse of leathern wing of sixteen feet, and took, perhaps, long and unwearied flights. What lives they led no man yet has told. But who can look on their petrified forms, and not feel a strange inquisitiveness about their habits? Were they ceaselessly on the wing, like the summer swallow after insect-prey? We think not, although there were great insects in those days—dragon-flies, beetles, grasshoppers. Hovering like hawks, did the little spalacotheria, triconodons, and plagiaulaxes tremble under the dark shadows of their sombre wings? We think not, although the bones of those tiny mammals swarm in the Purbeck beds. Like the albatross did the pterodactyles travel for days together over the watery main? Or, like the sea-eagle, did they swoop down on the placid fish as they came to the surface of the briny deep? We are not aware that any one yet has made a guess as to *what* the Pterodactyles fed upon; but we think it would be worth while to inquire whether the numerous cuttle-fish of those ages may not have been one source of nutriment.

In the Gault, near its junction with the Lower Greensand, there is a thin but regular stratum of broken ammonites impacted in a phosphatic paste, and very probably of coprolitic origin. May not this stratum have been derived from the excrements of the Wealden Pterodactyles? That they swarmed in our British area is evident from the quantities of their bones found with the nodules of the Cambridge Greensand; and if it be said that the Upper Greensand is a superior stratum to the Wealden beds, it might be urged on the other hand that it was probably a deeper sea deposit of contemporaneous age. The Iguanodons of the Wealden era *are* found in the Lower Greensand, why should not the Pterodactyles, whose bones and *débris* occur at Cambridge, have floated on their wide-expanded wings over the tangled forests of the ancient Weald?

It seems at first sight perfectly astonishing how few remains of birds have been preserved in a fossil state; but when the fragile pneumatic structure of their bones is taken into account the wonderment decreases. Still it does not cease, for we find the flying-lizards' bones preserved, and they are filled with air-cavities as are those of birds, although perhaps the bones themselves may be of stouter or more solid build. The true explanation of the matter seems to be that birds dying on the land were exposed uncovered on the ground, not only to the eyes of carrion-eating birds and beasts and to the attacks of insects, but were also subjected to the most powerful means of decomposition and decay—atmospheric influences. Moreover, the traces of former terrestrial surfaces have been very seldom preserved, and the instances that do occur are restricted in area and very rare indeed.

The first evidence that we have of birds, is in the Red Sandstone of Connecticut, formerly considered of Triassic but now believed to be of Oolitic age. Amongst the bird-prints of this rock, and they belong to many species of very different sizes, are some of gigantic dimensions, belonging, apparently, as we have said, to struthious birds. Wherever the rock is extensively quarried these large footprints are sure to be seen, and they are found throughout the whole thickness of the beds, amounting to many thousand feet. The ordinary stride of the bird was about three feet, and the length of the impress of its foot nine inches. There are, however, other footprints in this rock still more gigantic, measuring up to eighteen inches, belonging to birds that had a stride of five feet at every step they took. But although birds from these evidences have been known to have existed during the period of the Connecticut sandstone, since 1835, when Dr. Deane communicated his discoveries to his scientific friends, up to this hour only a few indeterminable bones have been met with.

In 1857 Dr. Emmons made known, under the name of *Palæornis struthionoides*, a portion of the sacrum of a bird containing six vertebræ anchylosed together, from the red and variegated sandstones of Anson County, North Carolina. The description of these ornithic remains is included by Dr. Emmons in his notice of the palæontology of the American Trias; but the nature of this relic and the possibility of its belonging to a large and heavy struthious bird would incline us to question its right to be referred to that age, until the actual period of the Connecticut sandstones, and the relationship of these red sandstones of Anson to them, is completely established.

The next evidence of the ancient existence of birds occurs possibly in the Wealden beds of the South-east of England. From time to time the late Dr. Mantell had obtained some fragments of delicate bones from the strata of Tilgate Forest, which he conceived to have ornithic characters, but the accuracy of this view was put in doubt when the so-called bird-bones from the Stonesfield slate were proved to have belonged to pterodactyles. Some further specimens, however, were obtained and submitted by Dr. Mantell to Cuvier and to Owen. Strengthened with the confirmation of such eminent authorities, the Doctor announced positively before the Geological Society in 1835 the existence of bird-remains in the Wealden formation, suggesting their typical resemblance to the corresponding bones in the heron (*Ardea*). These remains have received the classificatory appellation of *Palæornis Cliftii.* Subsequently, in 1845, Professor Owen retracted his opinion, and in a paper before the Geological Society expressed his conviction that these so-called birds' bones were really those of Pterodactyles. Dr. Mantell contested this recantation; and thus the matter remains. In 1857 the Rev. Mr. Dennis, of Bury St. Edmund's, proved, by an examination of the microscopic structure of some fragments of bone from the Stonesfield slate, the existence of birds at that epoch. The next traces of birds in time are the fragments found in the Upper Greensand of Cambridge by the late Mr. Lucas Barrett, who so sadly lost his life a few weeks since in a submarine exploration off the shores of Jamaica.* Of these remains or their relations we are unable to speak. They are not preserved at Cambridge; nor can Mr. Harry Seeley, the curator of the University collection, afford us any information about them. In the museum at Philadelphia, U.S., there are birds' bones from the Greensand of New Jersey—the equivalent of the European "Senonian," or Upper Chalk age —which have been referred by Dr. Harlan to the genus *Scolopax*, or snipe.

With the dawn of the Tertiary period, birds' remains become more numerous and varied in character. Cuvier has recorded eleven species from the gypsum of Montmartre. Owen has described the breastbone and sacrum of a vulturine bird from the London clay, of a smaller species than any now existing; Jourdain and Gervais have recorded bird-remains from tertiary strata of the south of France; and the German palæontologists others from the Miocene or middle tertiaries of Weisenau and Wiesbaden. From the Eocene period then there are species of turkey-buzzard (*Cathartes*), vulture (*Lithornis vulturinus, Lithornis ? emeuinus*), bald buzzard (*Pandion*), owl (*Strix*), protornis (*Protornis Glarisiensis*), kingfisher (*Halcyornis toliapicus*), curlew (*Numenius gypsorum*), snipe (*Scolopax*), sea-lark (*Pelidna*), sandpiper (*Tringa*), pelican (*Pelicanus*), and gastornis (*Gastornis Parisiensis*).

Of the Miocene age we have species of thrush (*Turdus*), finch (*Fringilla*), partridge (*Perdix*), fowl (*Gallus*, sp. and *Gallus Bravardii*), flamingo (*Phœnicopterus Croizeti*), stork (*Ciconia ?*), heron (*Ardea*), snipe (*Scolopax*), coot (*Fulica ?*), corvorant (*Phalacrocorax*), duck (*Anas*), merganser (*Mergus Ronzoni*).

In the Pliocene: falcon (*Falco*), snipe (*Scolopax ?*), and wild swan (*Cygnus ferox*).

From caverns and diluvial deposits there have been exhumed remains of turkey buzzard (*Cathartes*), vulture (*Vultur cinereus*), sparrowhawk (*Nisus*), falcon (*Falco*), buzzard (*Buteo*), eagle (*Aquila*), two or three common owls (*Strix*, two sp. and *S. nyctea*), and the screech owl (*Bubo*), wagtail (*Motacilla*), thrush (*Turdus*, sp. and *T. Bresciensis*), anabate (*Anabates*), swallow (*Hirundo fossilis*), finch (*Fringilla*, sp. and *F. trochanteria*), lark (*Alauda*), three or four crows and the raven (*Corvus fossilis*, *C. crassipennis*, *C. corone* vel *corax*, *C. pica ?*), woodpeckers (*Dendrocolaptes*, *Picus martius*), coua (*Coccyzus*), barbet (*Capito*), parrot (*Psittacus*), swift (*Cypselus collaris*), goatsucker (*Caprimulgus*), dove (*Columba*), dodo (*Didus ineptus*), solitaire (*Pezophaps solitaria*), grouse (*Tetrao*), partridge (*Perdix*, two sp.), pheasant (*Phasianus*), common fowl (*Gallus domesticus*), Guinea fowl (*Numida*), tinamou (*Tinamus*), nandù (*Rhea*, two sp.), dinornis (*Dinornis ?*), æpyornis (*Æpyornis*), buzzard (*Otis*), cariama (*Microdactylus*), stork (*Ciconia alba*), flamingo (*Tantalus Bresciensis*), snipe (*Scolopax*), rail (*Rallus*, two sp.), gull (*Larus priscus*, and *L. sterna ?*), swan (*Cygnus olor*), goose (*Anser*), duck (*Anas*, two sp.), and diver (*Colymbus*).

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* For a brief sketch of his life, see "Summary of Geology."

It will be here right to observe that it is more than doubtful whether the remains from caverns should be considered as of one age. The *Machairodus*, or great British tiger, is not believed to have lived down to the Post-Pliocene age, and yet its remains are found mingled with Post-Pliocene Mammalia in Kent's Hole and other caverns.

It may be that many of the caves and fissures containing osseous breccia, mammal, and other bones, were open during the Miocene age; and if one considers how long bones might remain under such circumstances uncovered by any preserving or time-separating deposits of mineral matter, it is easy to conceive how, by the tread of wild beasts, the irregular falling together of the bones themselves, as their muscles and ligaments decomposed, and by various other natural causes, a commingling in cave-accumulations of the relics of widely distant epochs could, and doubtless did, take place.

Alluvial deposits are, of course, the link between the past and present. As yet, however, they have been little worked, for the relics of this border-land between past and present time have not found much favour in the eyes of the geologist, and as little in those of the archæologist or naturalist.

The remains of dodo (*Didus ineptus*), solitaire (*Pezophaps solitaria*), two species of the singular wingless apteryx, ten or more species of the gigantic dinornis of New Zealand—some standing ten feet high, and some with three-toed feet twelve or fifteen inches long, three apteryx-like birds (*Palapteryx ginens*, *P. dromioides*, *P. geranoides*), aptornis (*Aptornis*), and the æpyornis (*Æpyornis*) of Madagascar, and its enormous eggs, capable of holding two gallons of water. These and the recently extinct moa (*Moa*), and notornis (*Notornis Mantelli*), of New Zealand, are sufficient to show the interest of the relics from alluvial strata, and the necessity of a better knowledge of their contents. The search after the early traces of Man will no doubt be ere long prolific in results to the naturalist, as well as to the anthropologist; and the knowledge of the animals and plants with which the pristine races of our kind were surrounded will be a subject of the greatest interest.

The above enumeration gives all the cases of bird-remains from every part of the world that are at present known; and as it is the full account of a whole class of animals, it shows very decisively the positive imperfections of the geological record as at present eliminated.

When Darwin first made the bold assertion that there were great gaps in the geological history, there was some disposition in scientific quarters to meet his assertion with scornful denial. Geologists had so prided themselves on what they had done, that they had never thought about what had been left undone; and it was soon found when reflection was turned to the subject that it was impossible for such a statement to be gainsaid. Attention has now been forcibly drawn to the fossil remains of this particular class by the discovery of an extraordinary bird in the lithographic slates of Pappenheim. This creature, so beautifully preserved that even the impressions of the feathers in the stone are retained, was first made known to the world as a supposed "feathered reptile," and has been lately purchased for the British Museum, and admirably described by Professor Owen. (Fig. 14.) As accounts of this extraordinary fossil have appeared in almost every daily and weekly journal, we need do no more than briefly refer to its prominent points, and the history of its discovery. In 1861, M. Andreas Wagner communicated to

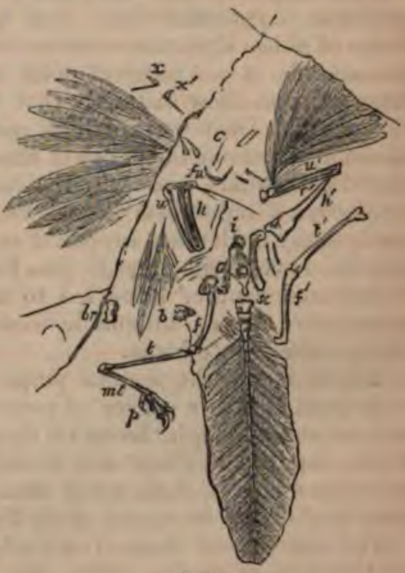


FIG. 14.

the Academy of Munich an account of the discovery of a fossil with divergent fans of feathers, of which he had been informed by M. Witte, the mayor of Pappenheim. Wagner, who was very ill at the time, in fact dying, never saw the specimen, but concluded, from the description he had received, that the remains must be those of a reptile, and named it the *Griphosaurus*. The familiar presence in the same beds of lithographic stone of flying reptiles, the Pterodactyles, aided Wagner's error, and a *furore* was created in the scientific world. After Wagner's death, the fossil was purchased from M. Häberlein, of Pappenheim, in whose collection it was, for our national collection,—not under the idea, however, that it was a feathered reptile, for both Professor Owen and Mr. Waterhouse were satisfied of its ornithic nature.

Bird-remains, so perfect and so extraordinary, and from so ancient a stratum, were, however, a desideratum of the highest scientific importance, especially when the creature possessed the extraordinary character of a long *vertebrate* tail.

After Professor Owen's elaborate and accurate examination, no doubt can remain as to its bird-like nature—the presence of a furculum or "merrythought," and the "perching" form of the leg and foot, with many other less prominent features, are sufficient to establish this. But it will be desirable to notice some of those abnormal characteristics which render it so very remarkable in a zoological point of view, and which make it imperative to show distinctly that it does not possess reptilian characters. The powers of flight possessed by the Pterodactyles, the long vertebrate tail of one of them—the *Rhamphorhynchus*—found in the same strata with the Archæopteryx, and the general tendency of naturalists to seek for, and perhaps too readily to accept, any evidences, supposed or real, of a transmutation of species, have in the present case fostered the original idea of a "feathered reptile," and led to a wide-spread readiness to accept the, as yet, untenable doctrine of the transmutation of flying reptiles into birds.

Flight is not the peculiar property of birds alone, although they possess it in a degree of perfection unknown to any other animal, and although through it they are clothed in garments of such exquisite delicacy and beauty; so essentially is it the prominent idea of their whole structure, that we have not only universally come to regard it as their special attribute, but as universally to view the bird as the typical and bodily expression of the *idea* of flight. Still, the bat flies, and the flying-squirrel (*Pteromys*) on outspread wing-sails shoots from bough to bough. Yet both are mammals; in the one the long fingers
ho fore-arms spread out the side-skin into wings (Plate XVII.,
8); in the other it is but the same loose expanded skin that

forms the sail. But the structure of the bird's wing is altogether different. The humerus bends back from the scapula (Fig. 6), the ulna and radius form the remige of the wing to which the quill-feathers are attached; while the carpals and metacarpals of the second and third digits form the pinion, and the carpals and metacarpals of the fourth digit are anchylosed together and form a little undeveloped finger of bone at the joint of the wing between the remige and the pinion. In the wing of the Pterodactyle (Fig. 7) the little finger is made to do duty as the yard to spread the sail of leathern skin, while the rest of the fingers provided with strong hooked claws extend beyond the wing-joint as clutches for the monster to hang on by, as bats and vampires do, to points of rock or boughs of trees.

The wing of the Archæopteryx has one or two claws (Fig. 15), or rather hooks, but so have recent birds. The *Parra jacana*, the *Palamedea*, the "spur-winged goose," the Syrian blackbird, are all examples. These claws—and in the Archæopteryx there might be, Professor Owen thinks, possibly three—are particular developments of those digits which ordinarily in birds are modified and disposed to form the pinion of the wing, and are not to be necessarily considered as in any way equivalent to the wing-finger of the Pterodactyles. They may have been used as hooks, but that they were so is not certain; and in the spur-winged birds the spurs are generally pointed, and usable apparently only as weapons of offence or defence. (See the Chaja Screamer, Plate XVI., fig. 10.) The reason, it is said, that "possibly the Archæopteryx had these two or three wing-hooks, is that these bones are displaced in the slab, and therefore *may* have been *washed* together. There is reason, however, to think that other osseous remains lying near to the hooks may be carpal bones.

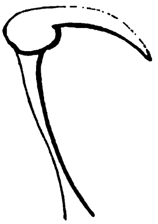


FIG. 15.

The form of the foot in the Archæopteryx is also decidedly that of a bird (Fig. 11). Its specialities may perhaps be best seen by a comparison with that of the Falcon (Fig. 13), or some other strong-footed, retractile-clawed, raptorial bird, between which class and the Perchers, the Archæopteryx will probably take zoological rank. In the *Geologist* for January last I pointed out the particular organs indicated by a cast of the brain-cavity of the skull, which has been remarkably preserved in the stone; and I would here draw attention to another portion of this wonderful fossil, which has hitherto received no published notice.

While the Archæopteryx slab presents us with the bones of the wing, the furculum, the ribs, the ischium, the numerous vertebræ of an extraordinary and long tail, into which the feathers were set in pairs,—while the imprints of these feathers are, as well as those of both wings, most delicately preserved, Professor Owen, in his wonderful description before the Royal Society, made no mention of the head; and that portion was believed to be absent from the block. I had, on the first occasion of seeing the reverse of the Archæopteryx block, noticed a ring of spar, which I considered as representing a part of the skull. A friend, to whom I showed it, differing in opinion, I did not press the point. Moreover, the block itself was under examination by Professor Owen at the time; and common courtesy demanded that I should not use any facilities afforded to me by the officers of the national collection in anticipation of the labours of so able and so competent an anatomist.

Some time after the reading of Professor Owen's paper, when Mr. John Evans,—struck with the resemblance of the concretion that had been formed within the ring of spar above noticed, to the two lobes of the brain,—made a cast of the brain-cavity of a crow's skull, my attention was re-directed to the subject, and I made a careful comparison of a bird's brain with the Archæopteryx concretion, and pointing out the actual parts of the brain shown in it, demonstrated (I suppose to the satisfaction of palæontologists, as no one has disputed my conclusions) that this cast represented the fossil brain of that creature. This evidence was confirmatory of the previous conclusions of Professor Owen, as to the ornithic nature of the fossil; for the characteristics of reptilian brains are so distinct from those of birds, that no tyro in anatomy could mistake the differences. If, therefore, "the feathered reptile" theory had any basis in fact, the Archæopteryx brain should have presented a pterodactylian, or reptilian organization, and not have agreed in every typical feature with the brain of a common bird.

Since the discovery of the brain my attention has been drawn to some very indistinct portions of crystalline substance on the surface of the slab, representing bone; for all the bones of the Archæopteryx are changed into calcareous spar, in which four or five little sparry points are to be seen. Mr. Evans, we are told, first detected these points, and assumes they are, or may be, teeth. From this he has inferred that the portion in question might be the jaws of the Archæopteryx. Mr. Davies, of the Palæontological Department of the British Museum, differed from this view, and pointed out to me specimens of fish of the same geological age as the Archæopteryx, with which he thought they agreed in form; regarding the bones with which they were associated as the maxillaries, &c., of a fish's head. As I was not, for zoological and anatomical reasons, disposed to believe that a bird's *beak* could be armed with teeth, I was inclined to accept Mr. Davies's explanation.

The "fish-head" theory did not, however, rest easily on my mind. I could not conceive why a fish's head should be mixed with the Archæopteryx's bones, instead of its own. The principle of taking another man's hat when you have lost yours did not apply. The fossil, like Conrad Gesner's "dragon," or the Japanese monster in the *Field* window in the Strand, was not made up of the head of one thing, the body of another, and the tail of a third. It was not a compound of the body and legs of a bird, with the tail of a Ramphorhynchus and the head of a fish, but was a veritable fossil undoubted from end to end and top to bottom. How a fish's head could get there, without any other trace of its body, fins, bones, or tail, was puzzling—not even a scale; and the lepidoid fishes—to which order, if any, this head, if it were one, must be referred—had thick, hard scales, which would not easily decay, and which could not, if there were any in the stone, be overlooked. Nothing but the head! seemed so strange that I was induced to make a careful comparison of the supposed fish-head with the inverted beak of a bird, to which a close inspection had led me to think it bore a resemblance.

Selecting purposely the skull of a raptorial bird, by the kindness of Mr. Geo. Gray, the opportunity of comparing it with the skull of the *Aquila Bonelli* has been afforded me; and, as I believe, with the probability of a useful result. I speak diffidently, because these particular bone-remains, so obscure as to have passed under the keen and scrutinizing eyes of the Superintendent of the British Museum without detection of their nature, are not data upon which one could be at all disposed to speak reliantly. Still, however, having come to the conviction that these shattered and altered remains (Plate XVII., figs. 1, 2) *may be* the veritable beak of the Archæopteryx, it is but right to make known the ground for that opinion.

Suppose, then, that the beak with the nasal bones, which are thin at the part joining on to the cranium, had rotted off, and had fallen, or been washed backward on to the mud, where they rested in an inverted and upturned position, ultimately by the pressure of the stony matter above becoming flattened and distorted. In this position the under surface of the fore part of the head would be seen; and supposing the lower mandible to be absent, we should have this enigmatical part of the fossil displaying the edge of the pre-maxillary and the indented impression of the upper side of the bill, a pterygoid plate on each side, and the two palatals either anchylosed together, or pressed up flattened in the inner space. But seemingly the lower mandible remains, with its rami pressed down over the pterygoid plates, to the shape of which it nearly conforms; so indistinct, however, is this portion, that it will be very difficult to assure oneself what it is.

That the breaking off of the beak in this way might happen, other fossils testify; as, for example, the Sheppey cranium figured by Koënig in his "Icones" as a *Larus;* and by Professor Owen in his "British Fossil Mammalia and Birds," as *Halcyornis toliapicus* (Plate XVII., fig. 5*a*), from which the beak is entirely absent. The figures of the lower mandibles of the Montmartre birds given in Cuvier's "Ossemens Fossiles," show what kind of traces they would leave (Figs. 3, 4), and some markings on the Archæopteryx slab are singularly like the imprint in Cuvier's Plate 155, fig. 1 (see Plate XVII., fig. 4).

In the British Museum there are many specimens of much interest besides this transcendentally valuable and instructive Archæopteryx. There may be seen limb-bones of the gigantic Dinornis, the New Zealand Moa, and the enormous foot-tracks in the Connecticut sandstone. There also are specimens of fossil feathers from Bonn and Aix, and the wonderful eggs of the Æpyornis. There too are strange unnamed bones from the Sivalik Hills of India. And these bird-remains may possess a higher interest hereafter for our readers when they know how rare are the fossil remains of the ancient inhabitants of the air.

EXPLANATION OF PLATE XVII. AND WOODCUTS.

Figs. 1 and 2. Supposed beak of Archæopteryx, or fish-head (Fig. 1 being the impression in the Archæopteryx slab of the beak, or fish-head, Fig. 1, in the counterpart of the slab).

Figs. 3 and 4. Lower mandibles of fossil birds from Montmartre.

Fig. 5. Cranium, without the beak, of the Sheppey bird (*Halcyornis toliapicus*).

Fig. 6. Wing of bird (*Falco peregrinus*). *s*, scapula; *h*, humerus; *u*, ulna; *r*, radius; *c*, carpals; *m*, *mc*, metacarpals; *p*, phalanges.

Fig. 7. Wing of Pterodactyle. *s*, scapula; *h*, humerus; *r*, radius; *u*, ulna; *x*, pinion (= little finger of human hand).

Fig. 8. Part of wing of bat. *u*, *r*, ulna and radius; *c*, carpals; *mc*, metacarpals, or wing-fingers; *t*, wing-hook (= human thumb).

Fig. 9. Head and jaws of Pterodactyle (*P. longirostris*).

Fig. 10. Part of wing of Chaja Screamer (*Chauna chavaria*), with two wing-spurs.

Fig. 11. Foot of Archæopteryx (natural size).

Fig. 12. Foot of a long-tailed Pterodactyle, from Pappenheim (natural size).

Fig. 13. A foot-claw of Falcon.

Fig. 14. Fossil remains of the Archæopteryx (about one-tenth linear). *c*, costæ; *s c*, scapula; *h*, humerus; *u*, ulna; *r*, radius; *i*, ilium; *f*, femur; *t*, tibia; *mt*, metatarsus; *p*, phalanges; *br*, brain; *b*, supposed beak, or fish-head; *x*, *x'*, carpal- or wing-hooks.

Fig. 15. Carpal-hook or wing-claw of Archæopteryx (natural size).

THE NATURAL HISTORY OF A BEECH TWIG.

BY HARLAND COULTAS.

EVERY part of a tree, whether it be leaf, shoot, branchlet, or branch, represents exactly the organic condition of the tree at an earlier period of its life, and one of the stages of development through which the entire tree itself has already passed. For it is plain that the tree was, at the commencement of the first year of its life, a single leaf; and at its close, a green herbaceous shoot, exactly like those annual growths which it now makes at the sides and extremities of its branches. In the spring of the second year, the buds formed by the leaves of the first year at the sides and summit of the first year's growth or shoot, developed into new growths or shoots, which were constructed after precisely the same pattern as the first year's shoot. They presented in autumn, when defoliated, precisely the same external appearances, having side and terminal buds, and the same peculiar form of leaf-scar. We are, therefore, necessarily led to regard them as only a repetition of the first year's shoot. For as the leaf is a unit, through the repetition of which the first year's shoot is formed, so, also, is the first year's shoot itself a unit, but of a higher and more complex character, through repetition of which the branches, and ultimately the entire tree itself is constructed. The whole tree is therefore represented in each of its parts, and if we take the terminal branches or twigs of a tree, and study them carefully, we shall obtain correct views not only of the tree during the first years of its life, but of those general and peculiar laws of growth which govern the entire tree itself.

To render the principle of these researches clearly understood, we have selected a beech twig, which the accompanying plate most faithfully represents.

By looking at Plate XVIII. the reader will see that the primary or central axis of the twig has put forth fifteen secondary axes or side-shoots. The figures in the plate, placed opposite the annular scars left by the winter leaves, will assist the reader in estimating the amount of growth made by the twig year after year; for he has only to bear in mind that these annular scars mark the place of the bud, or the terminal growth of the twig, during the year indicated by the figures, to place, as it were, its exact vegetative condition in a moment before his eyes, at any one of the previous years of its past life.

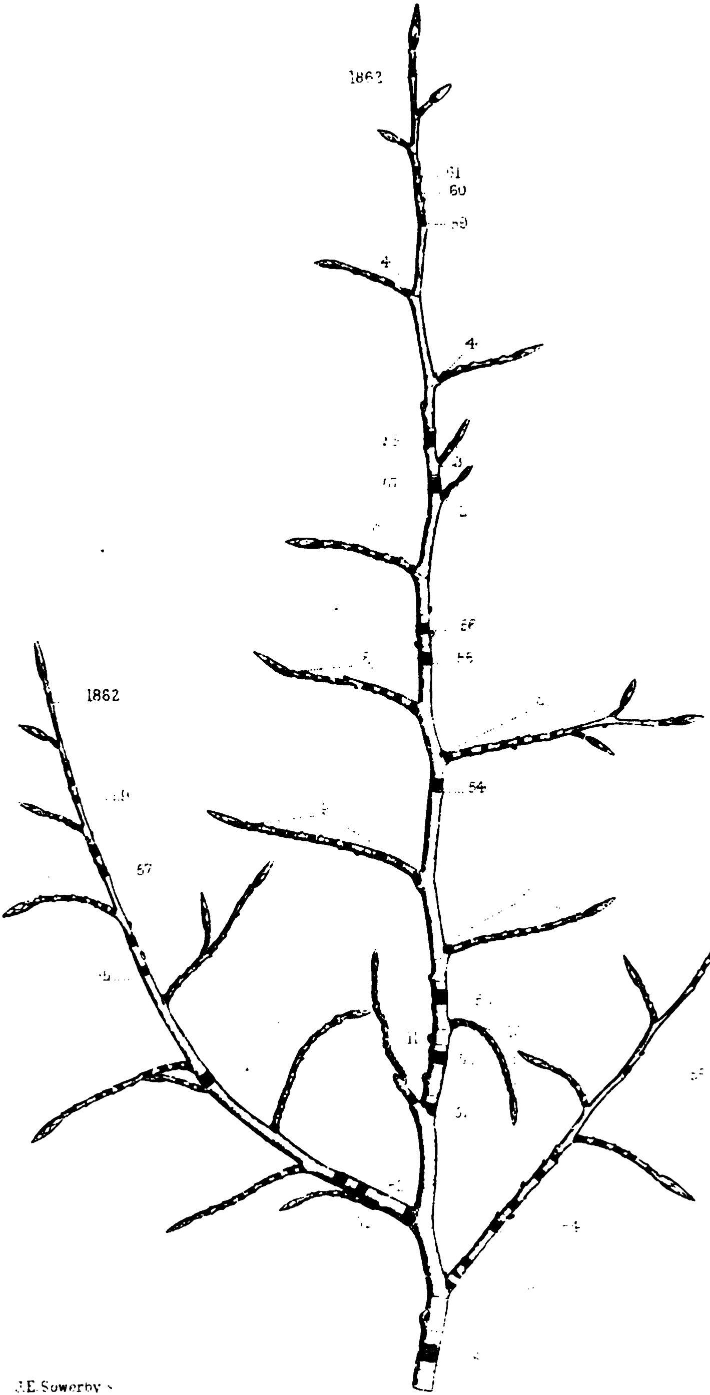
The twig represented by our plate was cut from one of the lower branches of an old beech, in Epping Forest, on the 7th of March, 1863. As there are thirteen sets of annuli on its main or central stem, it has evidently stopped growing thirteen times, and borne thirteen generations of winter leaves, and as many generations of summer leaves; consequently it is thirteen years old, and it must have commenced growing from the bud in the spring of 1850. It is also plain, that the first and second side-shoots remained in the bud condition throughout the whole of the year 1850, and made their first growth from the bud in the spring of 1851. Hence, only twelve sets of annuli can be counted on these two shoots; and the same law is apparent throughout the entire series of shoots, which are fifteen in number; each is one year younger, and will be found to have one set of annuli less than its parent stem. Thus the fifth branch above, the set of annuli marked 53, is numbered 9, because there are on its surface the marks left by nine generations of winter leaves, or nine sets of annuli; it is therefore nine years old, or one year younger than its parent axis, which numbers ten sets of annuli, counting from annuli marked 53 upwards, to 1862. Similar observations apply to shoots numbered 8, 6, and 4.

We must, however, except shoot 11 numbered 3, and shoot 10 numbered 2. These shoots were formed from buds which were matured in the autumn of 1857 and 1856, or five and six years ago. This is proved by the leaf-scar at the base of the shoot. Yet there are only three sets of annuli on one, and two sets of annuli on the other; consequently the former shoot must have been torpid for two, the latter for four years.

Another feature which presents itself for consideration, is the variation in the amount of stem between the sets of annuli. This shows that the growth varies from year to year, and that powerful growths are sometimes followed by growths greatly retarded. All twigs over whose surface the progress of yearly growths may be traced for a series of years, show more or less these marked differences of growth. Each branch has, in fact, its own peculiar history of growth, and trees differ not more widely in this respect than two branches on the same tree. In the consideration of a tree, we have to deal not with a product of crystallization such as the lead tree, or the dendritic formations on a frozen window, but with matter living and organized. The tree is therefore no stiff, unyielding form, but an easily impressible body, whose growth fluctuates with the favourable and unfavourable state of the weather from year to year.

The distance between two sets of annuli, estimated from the

Plate XVI



J.E. Sowerby

Common Beech: Fagus Sylvatica. L

upper and under limit of the rings, shows the amount of shoot developed during the season. The variability of these distances, or year's growths, is seen by one glance at the plate. The growth of the primary axis appears to have been accelerated and retarded five times during the thirteen years, or between the years 1851, 1854, 1857, 1859, and 1862.

A similar amount of variability is visible in the yearly growths made by the first and second side-shoots. In these two shoots, and in the central axis or stem of the twig, there is evidently the greatest amount of active vitality, and consequently their fluctuations of growth are the most visible and variable, beyond those of any other shoots in the series.

And here we would call the attention of the reader to the somewhat remarkable circumstance, that the yearly fluctuation of growth of the second or largest shoot corresponds with those of the central axis of the twig, upon which it would seem to have been dependent, whereas the first shoot or the one situated immediately below it has a fluctuation in its growth which is entirely different from that of the central axis, by which its growth does not seem to have been at all affected.

In the other shoots of this twig, vegetative life is approaching to a state of torpor or inactivity, and hence there is a much greater amount of uniformity, not only in their yearly growths but also in the number of leaves annually produced. In the fourth shoot, numbered 10, for example, the growth and foliage appears to be approaching a minimum. For ten successive years this shoot has only unfolded its terminal bud, thrown off its winter leaves, put forth two leaves the vital activity of which has been so enfeebled that they were only able to form two lines of clear shoot annually, between the successive sets of annuli, with which its surface is almost entirely covered. This shoot is also curved, which is another indication of its fast-failing powers of life, which the other shoots do not manifest. When shoots curve in this manner, it is nearly all over with them. A year or two more and the terminal bud loses the power of throwing off its winter leaves, because the summer leaves no longer form in its interior; the bud then dies. With the death of its terminal bud and the cessation of the formation of any more leaves, the further growth of this shoot must necessarily be completely arrested.

But not only the winter leaves, but also the summer foliage leaves behind it a peculiar scar on the bark, which marks the point of the stem to which the leaves were attached, and the number of leaf-scars between two sets of annuli therefore enables us to estimate correctly the number of leaves which were put forth during that season.

Now there are fifty-four leaf-scars on the central axis of our twig, many of which are represented in our engraving and may actually be counted in the plate if a small lens is used, such is the accuracy with which nature has been copied. The lines across the central axis indicate the position of these leaf-scars, for they are left by the stipule which was connected with each leaf as an enveloping and protecting organ. The fifteen branches, of course, originated from fifteen leaves. For instance, there are two lines visible, and three branches, between 1850 and 1851, on the central axis, which proves the attachment of five leaves to that portion of the axis. The first and second branches and the whole of the twigs with its shoots, above fifty-one, were then buds. Those buds indicate the position of three leaves which flourished during that season and brought them to maturity in autumn.

Again, there are altogether 299 leaf-scars on the side-growths of our twig, which proves it to be the work of 299 leaves. Evidence of the former presence of many of these leaves may be seen also with a glass on these side-growths in the lines and rudimentary buds left between the sets of annuli on their surface. Therefore the total number of leaves by which the entire twig was constructed was 54+299=353.

. The following is a true estimate as to the size of the twig. The length of the primary axis is twenty inches and three lines, and of the largest secondary axis ten inches and eight lines, yet it is the leaf-labour of 353 leaves. The twig itself we have shown to be only thirteen years old. What then must be the immense number of leaves engaged in the construction of trees which put forth thousands of such twigs, which grow from one to two hundred feet in height, and whose giant forms have stood for hundreds and even thousands of years? Who can estimate the quantity of leaf-surface spread abroad in the atmosphere from the first commencement of growth, and the amount of leaf-labour necessary to rear such lofty and enduring vegetable monuments? The Washington elm at Cambridge—a tree of no extraordinary size—was some years ago estimated to produce a crop of seven millions of leaves, exposing a surface of two hundred thousand square feet or five acres of foliage.*

The number of leaves which a tree puts forth during the season is undoubtedly regulated by the size of the dilated portion of the leaf, that is to say, its lamina or blade; if that be narrow the leaves are found in greater numbers on the tree. Compare in this respect the quantity of leaves on a willow with those on a horse-chestnut or maple. But this law is most apparent when the lamina or blade of the leaf is abortive, as in the linear needle-like leaves of the fir and pine.

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* "*First Lessons in Botany & Vegetable Physiology.*" By Asa Grey. 1857.

These make up by their immense numbers and their persistent nature for their want of surface, and thus contribute to the growth of the branches of these trees, as completely as those which possess a true lamina or blade.

Again, the increase of leaf surface each year, as ascertained by calculations made on the original twig, was as follows:—1851, 5; 1852, 10; 1853, 14; 1854, 15; 1855, 23; 1856, 28; 1857, 29; 1858, 36; 1859, 38; 1860, 37; 1861, 36; 1862, 40; 1863, 44. That is to say, in 1851 the twig put forth five leaves; in 1852, ten leaves, &c., &c.

It is worthy of remark here, that with every increase in the number of its absorbent surfaces or leaves, a young tree or branch must necessarily grow more rapidly. At any rate this law holds good up to the time when the tree begins to arrive at a maximum in its height and in the spread of its boughs; for till then the amount of leaf surface put forth in the atmosphere increases continually. When this period approaches, however, the vitality of the leaves put forth on the shoots at the extremities becomes enfeebled, and the shoots themselves become every year more and more circumscribed in their growth. The annual crop of leaves is now pretty much the same year after year. But the lofty tree, though it stands for hundreds and even thousands of years, has an appointed limit to its life, like the lowly flower that grows beneath its shade. Sooner or later it will begin to die at its extremities and decay in its interior, until at length the stem itself is merely a hollow living shell of wood, constituting the only bond of connection remaining between the roots and the branches which are still covered with verdure. As, however, branch after branch dies, the annual amount of its leafage necessarily diminishes. It is, however, extremely difficult to point out the several stages of stagnating and expiring growth, or to prove that a tree will ever die. In most cases death is brought about by violent interruptions to the natural life-processes. After having braved the storms of a thousand years, the tree is at last blown down and uprooted. Now busy, active, ever-industrious nature covers its fallen mouldering trunk with a shroud of moss and lichen, and there it lies in that forest grave-yard until it is again resolved in its original elements of earth and air.

The twig represented in the plate shows beautifully this gradual arrest of growth at its extremities, and also the diminution of annual produce in the foliage; thus illustrating clearly that law which governs the whole tree as it approaches the close of its allotted period of life. Let us confine our observations to the primary axis of our twig, which, with its little side-shoots, represents the massive stem and branches of the tree from which it was cut, on a smaller scale of architecture, being precisely the same in anatomical construction and governed by the same laws.

The tree from which this twig was cut was one of the oldest in the forest, and must have been growing for several centuries; the twig itself had only been growing for thirteen years, yet a transverse section of the primary axis of the twig, if compared with a cross-section of the stem of the tree, would show, notwithstanding their difference in size, the same parts, the pith in the centre, a number of concentrical rings of wood, and the bark on the outside. But in the twig, there would be only thirteen rings of wood, in the stem of the tree several hundreds. For each tree, each twig carries in its interior the monumental history of its life, and exhibits in the cylindrical woody deposits of each vegetative season marks which are ineffaceable excepting from the influences of decay.

Between the years 1850 and 1859, or for the first nine years, the growth of the central axis was nineteen inches and four lines; also, in 1851, the primary axis, which was then without a single shoot, only produced itself five leaves; but, in 1859, it had put forth eleven shoots, all of which were in foliage, making the entire leaf crop thirty-eight, or an addition of thirty-three leaves to the annual produce in eight years. But the growth of the primary axis, between 1859 and 1863, was only two inches and seven lines, with an addition to the annnal leaf-crop of only six leaves, and this, too, in four years. Our twig was, therefore, cut when it was approaching the limit of its vegetative progress, for its growth annually was stagnating, as is evident from the approximation of the sets of annuli at its extremities, and the slower increase in the annual extension of its leaf surface.

An animal may continue to live after it ceases to grow, but it is not so with a tree or a twig. For a tree or a twig continues to grow as long as it lives, and when it ceases to grow it ceases to live. This gradual and continuous stagnation of growth at the extremities of our twig is, therefore, also indicative of the fact, that its vegetative force was gradually expiring, and also shows that its life was rapidly drawing to its close.

Once more, we have seen that fifty-four leaves were employed in constructing the primary axis, yet only fifteen of them produced buds which became branches; also, that these fifteen branches, although constructed by 299 leaves, developed only fourteen shoots; for, referring to the plate, the reader will find that the first side branch produced three; the second, nine; and the seventh, two shoots; it follows that of these 299 leaves only fourteen produced vitally active buds, and that the axilla of all the others remained unfruitful. Therefore, the total number of abortive or rudimentary buds in the entire twig must be $353 - (15+14) = 324$.

Some of these 324 buds have retained a sufficient amount of vitality to carry them forward through the annually deposited layers of wood and bark, so that they still continue to maintain their position, year after year, on the outside of the bark. Several of these buds are visible in our plate on the surface of the central axis of our twig, and also on that of its first and second side shoots, and more may be detected on the surface of the other shoots, if the plate be examined with a small magnifier.

For example, there is a rudimentary bud on the primary axis, just below the set of annuli, marked 52, on the left side of the twig, which was matured by a leaf which fluttered in the winds and was bathed in the showers of the spring and summer of 1851; that leaf fell from off the axis in autumn, and left that bud on its surface, which has just life enough left in it to enable it to keep on the outside; that bud has been in that torpid condition for twelve years. And the bud, just above it, on the same side, nearly opposite that curved shoot, which is so instructive, was matured in the autumn of 1852, and has, therefore, been torpid for eleven years.

In cases like these where a bud has been formed by a leaf which has died years ago, and has maintained its position on the outside, if a section be made at the point of the stem where it is seen to protrude, the vegetative course of the bud will be marked by a line of pith, which traverses the several layers from the centre outwards.

In other instances the abortive buds of our twig died and were detached from the shoot the first year, or they retained their life but continued totally inactive. In the latter case the abortive bud necessarily sank below the surface, and became buried beneath succeeding annual deposits of bark and wood.

The trunks and branches of trees always contain an immense number of these buried buds, which may remain for years entombed below their bark in a state of passive vitality, like a seed which is buried in the ground.

Leaving out of consideration the rudimentary buds visible to the eye unaided, or assisted by a magnifier, on the surface of our twig, and supposing one half of the rest to have died, it is probable, even then, that there are more than a hundred abortive buds or points of vegetation buried beneath the bark of this little twig, only 13 years old, and 20¼ inches in length! What, then, must be the immense number of abortive buds in powerful branches which have been growing for centuries, or in the stem of a tree built by the leaf-labour of a thousand years. The vitality of those buds is not destroyed. Their parent leaves, it may be, have died and dropped from the tree many, many years ago, but they still retain unimpaired the life which they then received. Let some of the leading branches of the tree be broken off by the high winds of winter, and when spring comes they will attract the sap which went to those branches to themselves. This will arouse their dormant energies so powerfully that they will force their way through the wood and bark to the surface, though that wood may be the growth of years. The bud which has slept in a condition of feebleness, perhaps for half a century, will break forth at last into a powerful branch, the injury done by the hostile forces of nature will be repaired, and the tree will carry on successfully the battle for life.

All must be familiar with the sight of willows and other trees whose main branches have been thus broken off, and whose trunks are nevertheless covered with young branches and shoots, the growth of buds which have been buried in the wood and for years dormant beneath their surface.

We have thus, we hope, placed before the reader a simple and accurate method of studying the growth of trees. Of the tree it may be truly said that THE WHOLE IS REPRESENTED IN EACH OF ITS PARTS.

EXPLANATION OF PLATE XVIII.

Branch of Common Beech (*Fagus sylvatica*), showing its annual growths for thirteen years. The sets of annuli show the successive points where the growth was stopped during winter, and the figures opposite, the year when this occurrence took place.

REVIEWS.

COMPARATIVE PHYSIOLOGY.*

THE accomplished author of the *Souvenirs d'un Naturaliste* has produced under this title a very readable little book, which treats of one of the most complicated questions in physiology—that, namely, which has reference to the extraordinary variety of forms derivable from the same species among some of the lower animals, their mutual relation, and the analogies which may be discovered between them and some of the phenomena exhibited in the reproductive processes of the higher animals. There are few questions in the range of physiological inquiry which have raised greater feelings of wonder, or which have given rise to more speculation than those which have received the name of "alternate generation," "parthenogenesis," &c., while at the same time the obscurity and complexity of many of the phenomena have stimulated the curiosity of some, and deterred other investigators from entering upon a subject of so much difficulty.

M. de Quatrefages commences his work by pointing out that *change* is inherent in animal bodies, the highest no less than the lowest—plants and animals are momentarily losing some of their substance, which must be renewed; and this applies to all parts alike, the most delicate, and those which are most assimilated to inorganic bodies. He points out the defects in the general acceptation of the term *metamorphosis*, and proposes three expressions, each having a distinct meaning, to be applied to the very different forms of change which take place in various grades of the organic kingdom, viz., *transformation*, which includes the whole of the changes which a *germ* undergoes in its progress to the condition of an *embryo; metamorphosis* he retains to imply the changes which the animal undergoes after exclusion, and which profoundly alter the general forms, or the modes of life of the individual; while he proposes the new term *geneagenesis* for those changes which refer to the generations themselves—a term derived from γενεα, birth, and γενεσις, generation.

The transformations, then, which take place in the egg, or ovum, next occupy the attention, from the first appearance of organized tissue through all those remarkable stages which have of late years been so carefully and elaborately worked out and watched, more particularly by

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* "The Metamorphoses of Man and of Animals," by A. DE QUATREFAGES. (Métamorphoses de l'Homme et des Animaux, par A. DE QUATREFAGES.) Paris: J. B. Baillière, 1862.

German physiologists. The author, in passing, pays a just tribute to the celebrated Schwann, whose theories, at one time almost universally accepted, have long since been found to be formed upon false premisses and imperfect observations. But, as he observes, like all general doctrines which bind together a great number of isolated facts, this cellular theory has at once cleared and widened the field of research. Transformation, however, in the form of growth, continues to take place in the higher animals after exclusion, but it is worthy of remark, that it is often of a kind which Milne Edwards designates as *recurrent development*, as in the case of the higher monkeys, which at birth not a little resemble man, but, from a certain moment, their development, instead of raising them, lowers them in the animal scale, making more and more wide the breach between them and the human species.

The *metamorphoses* of animals in their restricted sense are of course best illustrated by those which are exhibited in the class of insects, in which there is apparently a sudden change from the grub to the chrysalis; and from the chrysalis to the imago or perfect insect. But these changes are really very gradual, and the aphorism "*Natura nihil fit per saltum*," is fully borne out in their case. We have not space to follow our author through the interesting and lucid details which he gives concerning the metamorphoses of insects in general, of myriapods, crustacea, annelids, molluscs, reptiles, and batrachians, all of which exhibit features of striking and peculiar interest. Instead, however, of regarding the various forms presented by an insect, for example, in each of its metamorphoses, as distinct beings, of which the first inclosed and nourished the second, (as Réaumur would have done,) by the light of modern science we are enabled to perceive that they are but the same being in stages analogous to those presented to our notice by the embryo, the fœtus, and the young of mammiferous animals. And the very proof which Réaumur invoked in favour of his view, viz., the dissections of Swammerdam, who could distinguish in the advanced caterpillar the antennæ, wings, &c., of the perfect insect, shows the gradual and progressive nature of the change to which they are subject. The caterpillar for us is an embryo which, in order to become adult, has not only to grow, and to develop itself as an infant would, but also has to pass through certain changes analogous to the embryonic changes of higher animals. The rapidity of growth, too, which is so remarkable a character in the primary conditions of insects, is one which is eminently analogous to the embryonic condition; and thus a larva may be considered as an independently existing embryo, which nourishes *itself*, instead of being fed by its mother, and undergoes externally, before our eyes, changes or *transformations* analogous to those which, in the case of viviparous animals, are accomplished within the maternal organism.

The phenomena of the third kind, which are placed under the collective title of *geneagenesis*, dovetail, as it were, into the other two, as facts of progressive growth and individualization. Here we find animals which, rigorously speaking, appear to have neither father nor mother, but only *a parent*, which forms them at the expense of its own substance. We find, as it were, sons which never resemble their father, and which produce children for ever different from themselves. We see a single germ produce not one individual, but multitudes of individuals, and sometimes several generations, which have no relation between them of form, structure, or mode of life. And, lastly, we see the germ lose its primitive individuality, and give place to a crowd of new individualities before the products of this very germ are arrived at the perfect condition.

The discoveries long since made by Peysonnel, Trembley, and others upon the generation of Hydra by means of gemmation and fission, and which caused at the time such universal interest, gave a great impulse to the early development of this question, and established the important fact that certain animals could, like plants, reproduce themselves by buds, appearing at first sight a deathblow to the doctrine of pre-existent germs. The succeeding great discovery, the origin of which is due to Chamisso, who announced in 1819 the alternations of generations of biphora (or salpæ), seemed as incredible as the adventures of Peter Schlemihl, his own "shadowless man." The new doctrine was first denied; then, when facts appeared too stubborn, attempts were made to explain them away; but the succeeding investigations of Sars and Von Siebold established incontestably the truth of these extraordinary disclosures of the secret workings of nature.

But the isolated observations of the first explorers of this new field were insufficient to give them any clue to the significance of these wonderful revelations. Modern science, however, has thrown much light upon the problem, and all these modes of generation are found to have something in common. In the case of the hydra, which reproduces itself by eggs, as well as by buds, it is as though there issued from the egg of a butterfly an animal having all the external character of the perfect insect, but deprived of organs of reproduction, which should produce by gemmation or budding beings like itself, and susceptible, as well as itself, of acquiring later the attributes of father and mother. In the case of the compound ascidians, it is as though the egg of the butterfly had produced first a caterpillar, and that this has arrived at its perfect condition; then, on this butterfly issuing from the primitive egg other butterflies like the first have made their way (*poussé*), of which the original one is, properly speaking, neither the father nor the mother, but only the *parent*.

Geneagenesis does not exhibit itself among true mollusca; but in the division of the *molluscoids* it appears to be the general rule. All these animals are more or less near in position to the biphoræ.

Among the echinodermata there appears to be a sort of connecting link between the two orders of facts above alluded to, and the gulf between the two is thus bridged. The whole animal comes under the category of geneagenesis; but many of the important internal organs undergo a simple metamorphosis. The doctrine of spontaneous generation, which has so often been bolstered up by the phenomena presented by the propagation of intestinal worms, can no longer resort to this support, since it is now found that the remarkable phenomena of alternate generation are exhibited in a strongly marked manner in this division of animals. All the pretended agamic species are now known to be only different phases of development of sexual species. These changes have, in many cases, been accurately followed, and analogy would justify us in believing that the same obtains with the remainder. We can, with more and more certainty, echo the aphorism of Harvey, "*Omne vivum ex ovo.*" The phenomena of geneagenesis mask, but do not alter, the principle of this great truth. Buds are the products of pre-existing germs,—secondary germs, in fact; and a gemmiparous reproduction suffices not to perpetuate the species, for at the end of a certain time reproduction by an egg becomes absolutely necessary. This alone is a function of the first order, to which gemmation is only subordinate.

In the latter part of his work, M. de Quatrefages combats the opinion of Professor Owen, of whom he speaks with the greatest respect, on the subject of parthenogenesis, and offers his own views of these phenomena; pointing out that, like multiplication by buds, or by suckers, natural or artificial, or by alternate generation, all of which he believes to be manifestations of one and the same grand phenomenon, so also *parthenogenesis*, or virginal reproduction, is but a particular case of geneagenesis, and, therefore, comes in the same category as those before mentioned.

The work of M. de Quatrefages abounds with original views and clear expositions of complicated and obscure phenomena, which he has brought into an ingenious and useful connection. We look upon it as the best that has appeared upon the difficult subject of which it treats, and should like to see it laid before the public in an English dress.

The Tropical World: a popular Scientific Account of the Natural History of the Animal and Vegetable Kingdoms in the Equatorial Regions. By Dr. G. HARTWIG, Author of "The Sea and its Living Wonders." London: Longman & Co., 1863.

THERE are, perhaps, few things which exercise so fascinating an influence upon the imagination of the student of natural history as the glowing descriptions given by travellers, of the aspects of nature in the tropical regions of the globe. Familiar as we all are with the moderate vegetation, with the sober tints of the birds and insects, and with the generally unimposing and harmless character of the quadrupeds and reptiles of our own temperate climes, the contemplation of the marvels of form, of size, of strength, and of colour, exhibited by the productions of the tropics, inspire us at once with admiration and with awe. Beautiful as are our leafy groves of oak and beech, resonant with the melodious voices of brown-coated birds, and tenanted by the stately forms of oxen or deer, they lack at once the grandeur and the grotesqueness of the strange and giant vegetation of the tropical forest; they lack the wondrous birds which, like living gems, dazzle the sight, as they flash through the sunshine, or settle in the shade; they lack the strange and unearthly sounds of the campanero, the howler, and the whip-poor-will, which seem to enhance the mystery of its gloomy recesses. Guided by the vivid descriptions of the veterans Humboldt and Waterton, we can picture to ourselves the pathless and interminable forests of Guiana, where Nature exuberates in perfect freedom from human interference—now revelling in dense and impenetrable thickets, entwined with thorny shrubs and woody *lianes*—now opening into a sheltered pool, bosoming upon its waters the gorgeous Victoria water-lily;—and we feel as if we could almost hear the strange, wild, and mournful sounds produced by the inhabitants of this enchanted region. These are well described by the author:—

> "Complete silence occurs only during very short intervals, for there is always some cause or other that prompts some animal to break the stillness. Sometimes the din grows so loud, that one might fancy a legion of evil spirits were celebrating their orgies in the darkness of the forest. The howling of the aluates, the whine of the little sapajous, the snarl of the douroucouli, the roaring of the jaguar, the grunt of the pecari, the cry of the sloth, and the shrill voices of birds, join in dreadful discord. Humboldt supposes the first cause of these tumults to be a conflict among animals, which, arising by chance, gradually swells to larger dimensions. The jaguar pursues a herd of pecaris or tapirs, which wildly break through the bushes; terrified by the noise, the monkeys howl, awakening parrots and toucans from their slumber, and thus the din spreads through the wood. A long time passes before the forest returns to its stillness. Towards the approach of day, the owls, the goatsuckers, the toads, the frogs, howl, groan, and croak for the last time; and as soon as the first beams of morning purple the sky, the shrill notes of the cicada mix with their expiring cries." (P. 84.)

We never tire of such scenes, and the mind feels an ardent desire to know more of these wonders. To few does the good fortune fall, of an opportunity of exploring for themselves such regions of marvels—to the many they are for ever the unapproachable fairy-land, which they were to our young imaginations. We therefore hail, with pleasure, the appearance of the goodly volume before us, which is devoted to the description of tropical nature, and affords a succinct, exhaustive, and accurate account of its leading animal, vegetable, and physical features.

Dr. Hartwig is already favourably known as the author of a work entitled "The Sea and its living Wonders," to which the present is in all respects a companion volume, of the same form and size, and with the same class and copiousness of illustration. Although these are often objectionably small, many of them are excellent, characteristic, and original, and greatly enhance the value of a work intended to convey useful information in a popular, but at the same time, scientific and accurate form. There are also eight principal illustrations, consisting of "chromo-xylographs" (which, being interpreted, signifies *tinted wood-cuts*), representing as many well-selected tropical scenes of striking interest. The plan of the work is threefold, the first giving an account of the general aspects (chiefly physical) of tropical nature; the second being descriptive of the wonders of tropical vegetation; and the remainder, or more than one-half the volume, is devoted to the varied and teeming insect and other animal life.

The aspects of tropical nature exhibit themselves under various forms, such as the thirsty Llanos, calcined grass-plains, presenting the monotonous aspect of interminable wastes, whose limits melt in the hazy distance with those of the horizon, and which in the dry, parched season sometimes catch fire, and are soon converted into a black and charred region of miles and miles in extent. But let the tropical rain fall upon this arid and thirsty land, and vegetation springs up with almost miraculous rapidity, and "the dull tawny surface of the parched Savannah changes as if by magic into a carpet of the most lively green, enamelled with thousands of flowers of every colour." The Puna, or uninhabited region of high table-lands in Peru and Bolivia, though situated near the Llanos, in the torrid zone, yet being elevated from 10,000 to 14,000 feet above the sea, contrast with them in their bleak and unfriendly climate, constantly liable to wintry storms and sudden changes of temperature, as much as 45° in a few hours. In such unfriendly regions a few stunted shrubs and dense grass form the characteristic vegetation; and from these the useful llama and alpaca derive subsistence, the wool which protects them from the inclemency of the situation being one of their chief attractions. In Africa, the Kalahari and the Sahara—though both deserts—are not both equally inhospitable; for while Sahara, extending from the 30th to the 70th degree of N. latitude, is a dreary waste, redeemed only by bright green oases, which break its monotony, like the charming islands which stud the vast solitudes of the Pacific, the Kalahari is far from being destitute of animal and vegetable life. It contains but little water, but in no other respect can it be called desert, being covered with grass and creeping plants, while the Caffre water-melon covers the ground in some seasons with juicy gourds. Koodoos, gemsbocks, elands, and other antelopes may often be seen here forty miles from the nearest water; and other game, such as rhinoceri, buffalos, gnus, and giraffes are not unfrequent in its immediate neighbourhood. To each of these characteristic regions, as well as to the Peruvian sand-coast, the Mexican plateaux, the mighty Amazons, in the West, and the Sikkim slopes and mangrove swamps in the East, is an interesting chapter devoted in the work before us.

The characteristic forms of tropical vegetation consist of trees often of gigantic size, such as the baobab, or Adansonia, more than a hundred feet in circumference, though only about sixty feet high; great dragon trees (*Dracænas*), sycamores, and the widely-renowned banyan (*Ficus indica*), each tree a little grove, sending out in the case of a celebrated one on the banks of the Nerbuddah 3,000 root-trunks, still covering a space of ground 2,000 feet in circumference, and once known to have afforded shelter to 7,000 men. Often to beauty of foliage and majesty of form there is superadded a delicious aroma, as in the sandal-tree of the Malabar coast; or the attention is arrested by a strange grotesqueness of form, as in the giant cacti of the New World, some remarkable specimens of which are figured in Plate 4, rising in angular columns to the height of 60 feet, generally branchless, sometimes strangely ramified as candelabras, while others creep like ropes upon the ground, or hang snake-like from the trees. In similar situations to the last are "endless varieties of epiphytal plants of inconceivable size and luxuriance, such as ferns, bromelias, tillandsias, orchids, and pothos, covering the trunks and branches of the forest trees with hanging gardens far more splendid than those of ancient Babylon." But the palms must not be forgotten—the trees of all others the benefactors of man—whose three hundred and sixty uses have been sung by the Eastern poets. "Some years ago a ship from the Maldive Islands touched at Galle, which was entirely built, rigged, provisioned, and laden with the produce of the cocoa-tree." Graceful in form, and fertile in valuable and useful products, many species may yet be considered to possess virtues which, at present undeveloped, may be destined to hold important rank in the future commercial annals of the world.

To the exuberant fertility of this zone *we* are also indebted for abundant vegetable nutritive products,—rice, maize, arrowroot, sugar, coffee, cocoa, &c.; important spices, as nutmeg, cinnamon, cloves, pepper, and ginger; dyes, as indigo and dyewoods; manufactures, as cotton, caoutchouc, and gutta percha—all indispensable adjuncts to civilization, all demanding the heat and the light which the tropics alone can afford, and all finding a place in the volume before us.

But the tropics, rich and fertile as they are, attractive enough to cause a mutiny of the "Bounty," are not without their drawbacks, and the worst of these are, perhaps, to be found in the insect world. Mosquitoes in clouds, protected by their numbers and their minuteness, "murder sleep." Chegoes, or jiggers, insinuate their nests into the feet and toes, and, if allowed to remain, cause their victims to be "lamed for life, and become loathsome to the sight;" blood-sucking ticks and *bête-rouges* produce painful sores on the undefended parts of man; while the tzsetse-fly, or zimb, is the scourge of cattle, so terrible and so fatal, that "had any one of our indigenous flies similar poisonous qualities, we should never have been able to escape from barbarism." Locusts and cockroaches are ever ready to devour everything, and are, in their way, no less important plagues. Against these we may place the silkworm and cochineal insects as absolutely invaluable, and a host of others are at once harmless to man and marvellous in their form, size, or habits. Gigantic beetles, the elephant, typhon, hector, and goliath, fighting mantises, leaf and walking-stick insects—those singular freaks of Nature, bright lantern-flies, and luminous beetles are among these. Ants and termites as wonderful as our own bees, if not more so, from their wondrous societies, unwearied industry, and astonishing intelligence, are inexhaustible sources of interest; and though some are formidably armed and dangerous neighbours, they are not without their uses. The ranger-ants of West Indies sting cruelly, but their appearance is the death-warrant for every spider, scorpion, cockroach, or reptile that pollutes the dwelling.

The dangers arising from the bite of venomous serpents appear not to be so great as is generally imagined. Sir E. Tennent frequently performed journeys of two to five hundred miles through the jungle in Ceylon without seeing a single snake. They are easily alarmed, and hastily retreat, and only when suddenly surprised do they wound, and then in self-defence. Add to this, that but a small minority of snakes are poisonous, twenty-one out of ninety-one in tropical America, seven out of forty-three in India, and four out of twenty in Ceylon, and it is evident that the terrors of the serpent kind are usually somewhat exaggerated. Still the cobra, the bushmaster, and the rattlesnake are sufficient to strike terror into the boldest heart, and for these the whole race must be proscribed.

We must pass over the wonders of tropical bird-life, the painted toucans, the gemmed humming-birds, the military-looking flamingoes, the grotesque hornbills, the golden honey-eaters, the great soaring condors, and the greater running ostriches, the noisy parrots and macaws, and the delicate-plumaged cockatoos, and devote the remainder of this notice to one or two of the characteristic mammalia of tropical regions. Here we have adventures by flood and field, in the chase of the ungainly hippopotamus, the savage rhinoceros, and the massive elephant. In the hippopotamus we should hardly expect to recognise much intelligence, or to credit much of the god-like attribute of memory; but he seems to have both where they may serve his purpose, or help to self-preservation. "It knows how to avoid pitfalls, and has so good a memory that when it has once heard a ball whiz about its ears, it never after ceases to be cautious and wide awake at the approach of danger." (P. 435.) Like elephants, certain solitary individuals appear to have a special bump of mischief, and are called *rogues* for their cunning and instinct for its gratification.

The account of the lion is specially interesting in connection with the paper by M. Jules Gérard, in the present number of this Review. "Man," says Dr. Hartwig, "judging from outward appearances and attributing to external beauty analogous qualities of mind, has endowed the lion with a nobility of character which he really does not possess; for modern travellers who have had occasion to observe him in his native wilds, far from awarding him the praise of chivalrous generosity and noble daring, rather describe him as a mean-spirited robber, prowling about at night time, in order to surprise a weaker prey." We will conclude our notice of this most interesting and instructive volume with a passage which places the moral character of the lion--if we may so describe it—in a somewhat novel light.

"When, so say the Bedouins, a single man meeting with a lion is possessed of an undaunted heart, he advances towards the monster brandishing his sword, or flourishing his rifle high in the air, and taking good care not to strike or shoot, contents himself with pouring forth a torrent of abuse:—'Oh thou mean-spirited thief! thou pitiful waylayer! thou son of one that never ventured to say *no!* think'st thou I fear thee? Know'st thou whose son I am? Arise, and let me pass!' The lion waits till the man approaches quite near to him; then he retires, but soon stretches himself once more across the path, and thus by many a repeated trial puts the courage of the wanderer to the test. All the time the movements of the lion are attended with a dreadful noise: he breaks numberless branches with his tail; he roars, he growls; like the cat with the mouse, he plays with the object of his repeated and singular attacks, keeping him perpetually suspended between hope and fear. If the man engaged in this combat keeps up his courage,—if, as the Arabs express it, *he holds fast his soul,*—then the brute at last quits him, and seeks some other prey. But if the lion perceives that he has to do with an opponent whose courage falters, whose voice trembles, who does not venture to utter a menace, then, to terrify him still more, he redoubles the described manœuvres, he approaches his victim, pushes him from the path, then leaves him, and approaches him again, and enjoys the agony of the wretch, until at last he tears him to pieces." (P. 468.)

THE CHANNEL ISLANDS.*

THE Channel Islands have deservedly "won golden opinions from all sorts of people," who have had the good fortune to make their acquaintance. Among them there is delightful boating, unrivalled sea-fishing, a genial climate, and plenty of scope for "pic-nicing" and sea-shore rambles. There is abundant employment, too, for the naturalist, the artist, and the antiquarian; and there is much to interest the student of men and manners,—much in the current customs of the islands which appears to us quaint and antiquated, being, in fact, lingering relics of the Mediæval period.

It is true that the scenery of these islands is nowhere on a very grand scale, but it is always pleasing, and often highly picturesque and impressive. The highest point of Sark—the wildest of the group—is only 365 feet above the sea-level; but the imposing effect of its scenery is out of all proportion to its really trifling dimensions. Each island has its own peculiar character more distinctly marked than one would suppose likely in a group so nearly associated. The coast-line is very diversified, sometimes showing gently-sloping sandy beaches of considerable extent, at others forming secluded little bays, each with its narrow strip of silvery sand, enclosed by walls of rock which rise steeply in the most picturesque variety of form, richly dyed with lichens and mosses, and washed by a sea most "deeply, darkly, beautifully blue." We cannot call to mind a more lovely example of this kind of scenery than the well-known Moulin Huet Bay, in Guernsey. The south of Guernsey and north of Jersey afford many scenes of this class—beautiful nooks, which once seen, cannot fail often afterwards to "flash upon that inward eye which is the bliss of solitude." Of a totally different character is St. Ouen's Bay, in Jersey, the noblest of all the bays of the Channel Islands, bounded by a range of sand-hills, from which the loose sand has been swept in eastward, converting a large tract of country into one great desert. Respecting this singular district, Mr. Ansted says:—

> "Owing to the prevalence of westerly winds, the sands covering the wide flat of St. Ouen's Bay—the largest expanse of unbroken sand in the Channel Islands—are blown steadily onwards, and have at length not only covered the low hills near the shore, but have risen to, and partially overwhelmed the table-land of the interior. It is extremely interesting to watch this almost African expanse of undulating sands from the coast, in windy weather. The horizon is lost in the misty air, loaded with fine particles of sand, constantly in motion, whether the gale comes from the west or from the east. Since, however, winds from the former quarter

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* *The Channel Islands.* By DAVID THOMAS ANSTED, M.A., F.R.S., &c., and ROBERT GORDON LATHAM, M.A., M.D., F.R.S., &c.; with illustrations drawn by Paul J. Naftel, Member of the London Society of Painters in Water Colours. London: W. H. Allen & Co.

> are both more frequent, and blow steadily up a continuous slope from the sea, while the latter are little felt near the lower ground, the ridge of the hill serving as a shelter, the result is an unmistakeable advance inland, and farms, houses, and even villages, become gradually obliterated. Much grass, of that peculiar kind that roots in loose sand, has been allowed to grow, but it is quite insufficient to check the evil."

We must not, however, dwell longer on the scenic attractions of the Channel Islands, our object being to notice, in connection with the work whose title is appended to this paper, some of those features which possess special interest for the naturalist. We have been fortunate enough to have spent two very delightful summer holidays in investigating several branches of their natural history, and can cordially recommend any brother naturalist to whom the islands are unknown, to go and do likewise. Whatever branch of science occupies his attention, he may be pretty sure of finding abundant material for study. The islands are, moreover, very easy of access, and the expense of living, though not so exceptionally small, as in the good old times, when tourists were few and far between, is, at any rate, very much less than at most sea-side resorts.

It is interesting to note that the most picturesque and characteristic scenery of the Channel Islands—the caverns, detached pinnacles, and "creux," are at once the result and the evidence of a constantly progressive destruction. Professor Ansted thus sums up the conditions under which these results are produced :—

> "Nowhere on our shores is the tidal wave so powerful, nowhere are the storm waves so frequent; nowhere is there a coast consisting of material in which so much rock of extreme hardness is penetrated so thoroughly with veins of softer material. The very hardness of the granite, where it is hard, produces an unusual destruction of the softer veins ; for, as already explained, every fragment removed becomes a hammer, helping to undermine what is left. Whenever one hard mass is thrown down and broken up, another is soon attacked ; and thus a perpetual and rapid destruction is caused, increasing constantly in area, and not diminishing in intensity."

This destruction goes on so rapidly as materially to alter the rock surfaces in a very short lapse of time ; and it is certain that in historic times the general aspect and contour of the islands must have undergone very material change. Nor is this the only actively destructive agent. Earthquakes have been frequently felt, and even so lately as 1843 and 1853 shocks so violent as to cause great alarm have occurred.

The tides in the Channel Islands are the perplexity of dredgers, and add much by their violence and variable direction to the dangers of the coast. On this account, indeed, it is quite unsafe to venture on dredging or any other kind of boating without the help of experienced sailors. In many places the rush of the tide is tremendous. Through the narrow channel, for instance, between Sark and the Gouliot Rock, it sets with the impetuosity of a great river in flood ; and we well remember that in passing through with a fresh breeze and all sail set, it was all our boat could do to make head against the stream. A most beautiful and accurate view of this spot is given by Mr. Naftel at page 81. The complicated character of the tides will be understood from the following remarks :—

"The course of the tidal wave through the waters that surround the Channel Islands may be thus stated. The great wave coming in from the Atlantic advances from the south-west, and is turned to the east. A part of it passes on to the north-east, north of the islands; but a part enters among them by various channels, and being first lifted by shoal water, and then thrown back by the coast of Normandy, it is both detained in its course, and is deflected to the north. At Mont St. Michel the magnitude of the wave is at its maximum. Owing to the vast extent of the shallow water, and the narrowness of the deeper passages throughout the great bay enclosing the islands, the wave remains extremely large, amounting in Jersey to nearly forty feet, in Guernsey to almost thirty. . . . . The velocity of the tidal current, where not increased by narrow passages, is from two and a-half to three miles per hour. Although the course of the tidal wave may be thus traced, the current by no means follows the same law. In this respect the complication is so great that it would be quite impossible to describe it in this place; but, in a general way, it may be stated that the stream does not flow northwards with the advancing tide wave in the open channels till the wave has been flowing three hours, and that when it has turned it continues in that direction not only till the flood has turned, but till the retiring wave has receded half its course. In other words, the stream flows from half flood to half ebb, and ebbs from half ebb to half flood. While, however, this is the case in certain channels, the direction of the stream is not only different, but often diametrically opposite, at no great distance, but somewhat nearer shore."*

A visitor to Guernsey cannot fail to be struck with the great luxuriance of vegetation, especially of exotic forms. Plants which in England we are accustomed to regard as delicate or half-hardy, there thrive wonderfully, without any extraordinary care being bestowed upon them, even in winter. Hydrangeas and fuschias are particularly abundant, adorning almost every cottage garden with masses of bloom, which would be the pride of many an English conservatory. Fuschias attain the height of fifteen or twenty feet, and are rather trees than shrubs. The splendid Mexican aloe, *Agave Americana*, grows freely, sending up its gorgeous flower-stalks thirty or forty feet high. Yuccas, the *Camellia japonica*, and numerous exotic bulbous plants flourish in the open air. The well-known Guernsey lily is an example of the latter class; and, says Professor Ansted, "the great beauty of the rich red flower of this lily, and the fact that it flowers regularly once in two or three years in the island, while it can seldom be made to flower a second time in England, are subjects of great pride to the islanders." Nor is this richness of vegetation confined to cultivated plants: the indigenous flora affords many illustrations of the great geniality of the climate. Fronds of the sea, spleenwort (*Asplenium marinum*), have been gathered three feet in length;† and in every lane some of the commoner ferns, such as *Asplenium adiantum-nigrum*, and *Scolopendrium vulgare*, are to be found growing in the greatest luxuriance. Guernsey exhibits this richness of vegetation in a much greater degree than any of the other islands; the reason being that its more seaward situation brings it more decidedly under the warming influence of the gulf stream, at the same time removing it further from the disturbing influence which the proximity of a great continent must to some extent produce. The tables of temperature given in the work before us exhibit very clearly the remarkable equability of climate enjoyed by the Channel Islands, and by Guernsey more particularly. For details we must refer the reader to the work itself; but the following table will show at a glance sufficient reason for this remarkable luxuriance of vegetation:—

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* "Between Guernsey and the Casquets the current sets from every point of the compass during each advance and recession of the tidal wave; hence the navigation is exceedingly difficult and dangerous in foggy weather, ships being sometimes drifted miles out of their course."

† In the South Isles of Arran, Galway Bay, we have gathered fronds of this plant of a similar size, and *Adiantum capillus veneris* nearly as large. The two ferns grew together in perpendicular rock fissures on the beach, and, whatever the depth of the fissure, they sent up their fronds to the level, or

	Greenwich.	Guernsey.
Mean temperature of		
Spring months (March, April, May) . .	46·9°	47·7°
Summer months (June, July, August) . .	60·6°	59·9°
Autumn months (Sept., Oct., Nov.) . .	49·9°	53·8°
Winter months (Dec., Jan., Feb.) . . .	38·2°	44·2°

The lists of the flora and fauna given by Mr. Ansted, though the work of many able hands, are confessedly incomplete, excepting those of the flowering plants and ferns, which are all based upon Mr. Babington's "Primitiæ Floræ Sarnicæ." The catalogue of seaweeds includes two hundred and twenty-two species,—an extensive list, the whole number of recorded British species being about three hundred and ninety. The islet of Herm is not represented in this list, and from our own gatherings there we can add the following species:—*Callithamnion floridulum* (very abundant), *Cladophora diffusa*, and *C. gracilis*, *Elachistea pulvinata* and *E. scutulata*, *Leathesia tuberiformis*, *Melobesia calcarea*, *M. lichenoides*, &c., *Mesogloia virescens*, and several others. It is worthy of notice, however, that the red algæ in Herm are mostly very poor in colour, owing to the deficiency of shelter from sunlight: they are more frequently yellow or green than red, except on the east coast, where the rocks offer more shade. The lists of Crustacea, both stalk-eyed and sessile-eyed, are also very imperfect. Amongst the former, for example, of the genus *Pagurus*, only two species are given: in addition to these we may name *P. lævis*, *Hyndmanni*, *cuanensis*, and *ferruginens*. But, notwithstanding unavoidable imperfections of this kind, the lists are very valuable as an attempt to illustrate thoroughly the botany and zoology of the islands, and will form an admirable nucleus around which the discoveries of other observers may be gathered.

We have already noticed the peculiarities of the Channel Island scenery, and have not space for more than the following short extract,

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nearly to the level, of the surrounding rock. A more favourable condition for fern growth it is impossible to conceive; the successive growth and decay the leaves producing a constantly accumulating rich and loose soil, while sides of the rock crevices afforded abundant shelter.

descriptive of the celebrated Gouliot Caverns in Sark, which may well be called the El Dorado of the British naturalists:—

> "The first cavern is of noble proportions, and the floor is roughly piled with immense boulders, giving many and varied views of the small but picturesque 'Havre Gosselin,' seen through the opening at the further extremity. But this cavern, though fine, is, as it were, a mere outer court, preparing us for the glories to be revealed within. Its walls are partly covered with those singular currant-jelly-like animals one sees expanded like living flowers in marine aquaria; deep blood-red is the prevailing colour, but dark olive-green varieties are also common, and numerous yellow and brick-red patches are seen at intervals. A few mussels and tens of thousands of limpets and barnacles cover the boulders. Abundance of life is seen, and some of the specimens are as rare as they are beautiful. A branch of the first cavern, in which is a deep pool of water, conducts to the sea; but it is better to wait till low water and creep round outside. We then enter a gloomy series of vaults, lighted from the sea, and communicating with each other by natural passages. Every square inch of the surface is covered with living zoophytes; and in some parts an infinite number of *Tubulariæ* are seen occupying the walls."

The work from which we have extracted is edited jointly by Messrs. Ansted and Latham, the former having contributed the sections embracing Natural History and Physical Geography, as well as the Economics and Trade of the Islands; the latter being author of the chapters on Civil History and Antiquities. That the whole has been admirably performed cannot admit of doubt. The volume is beautifully printed, and contains numerous illustrations of scenery by Mr. P. J. Naftel. These are most artistically executed, and are faithful as well as pictorial: we know no other engravings which so agreeably reproduce the character of the Channel Island scenery.

THE ORIGIN OF SPECIES.*

(MR. DARWIN AND HIS COMMENTATORS.)

THE minds of men are so variously constituted that the observation of one and the same phenomenon often produces upon different individuals totally distinct and opposite impressions.

As in the tale of the travellers and the chameleon, one person examines an object from one position, and declares it to be white; another views it from a different stand-point, and unhesitatingly affirms that it is black; whilst a third, approaching it from the quarter where the two effects neutralize one another, pronounces it to be both, or neither, and at length discovers that it is grey; and he at once proceeds to enlighten the disputants.

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* Professor Huxley's Lectures to Working Men on "Our Knowledge of the Causes of the Phenomena of Organic Nature." R. Hardwicke.

Are we correct (we would inquire of the thoughtful reader), when we say that the debated controversy of the "Origin of Species" has assumed somewhat of this aspect to one who belongs to neither rank of controversialists?

Leaving out of consideration a host of writers, who have dealt with the subject without understanding anything of its merits, or who have formed hasty or prejudiced conclusions in regard to it, we still find many illustrious names rendered still more prominent by their association with that greatest of all nature's problems—the creation, modification, and continued existence of living forms; and where the leading naturalists of the age are found to hold diametrically opposite views, we can take but little credit to ourselves for having exercised caution in the expression of our own opinions.

But those who have followed us in our labours will be aware that we have done more than to exercise self-control; we have often (no doubt to the dissatisfaction of our correspondents) toned down, or entirely expunged statements which assumed as undeniable facts what many unprejudiced observers still regard as not proven, or even reject as error; and this we have done in order that a hasty expression of opinion on the one side might not call forth an acrimonious retort from the other.

The result has been that these pages are the neutral ground upon which men and women holding every phase of theological and political belief have met without restraint, and have learned to respect one another as searchers after truth. And it is chiefly with a view to maintain this prestige that we now venture to approach a question which will not allow itself to be cast aside; and upon which it is, therefore, right that each and all of us should bring our best judgment to bear.

During the brief period of the existence of this Periodical, we have had occasion to notice three works bearing upon the subject of the "Past and Present Conditions of Organic Nature;"* all written by authors whose names are more or less intimately associated with the controversy; and now there lies before us a fourth treatise, an unpretending little volume, so far as outward appearance goes, and comprising only 157 small widely printed pages of matter. But this little work, diminutive though it be in its proportions, contains the deliberately expressed convictions of a naturalist who is invested with great authority by virtue of his official appointments in the educational departments of the State; and whose careful and untiring research gives weight to any opinions that he may think fit to express in public on those subjects which (to confine ourselves for the present to an expression of his own) tend to "the improvement of man's estate, and the widening of his knowledge."

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* "The Past and Present Life of the Globe." By D. Page. Blackwood. (No. 1, "Popular Science Review.") "Unité de l'Espèce Humaine" (Unity of the Human Species). By De Quatrefages. Hachette, Paris. (No. 2, "Popular Science Review.") "On the Fertilisation of Orchids." By Charles Darwin, author of the "Origin of Species." Murray. (No. [illegible] "*Popular* Science Review.")

It deals with "the past and present condition of organic nature;" with the method by which the causes of these conditions of nature are to be discovered; the origin and perpetuation of living beings, and the phenomena that accompany these. It further enters into a critical examination of Mr. Darwin's book on the origin of species, suggesting to its readers how far they should be guided by the theories and hypotheses which it contains; and lastly, what is to us by far its most important feature, it is itself a verbatim report of a course of lectures delivered by the author (we believe in his public and official capacity) to the working classes of the great metropolis.

Our readers will therefore perceive that we are not called upon to deal with a mere scientific inquiry or criticism, of whose value every one may form a more or less accurate estimate, but that the doctrines and conclusions of the author will be taken for granted by, and serve as a guide to many who were previously unacquainted with the subject except by hearsay; whilst others more enlightened, perhaps, but still to a great extent strangers and new-comers in the world of science, will carefully scan its contents *as the popular exposition of the great scientific movement of the day;* and such persons will naturally form from its contents what appears to them to be the most accurate estimate of the efforts of modern science as applied to the laws of nature, as well as of the opinions held by scientific men.

The avowed purpose of the present work is, as already stated, to communicate to the partially educated masses what appears to the author to be a faithful account of Mr. Darwin's views concerning the origin of species, and to convey his (the author's) unbiassed opinion as to how far these views are entitled to their acceptance.

With this object, it may readily be supposed, that the author would find it necessary to impart to his readers some knowledge regarding the past and present condition of organic nature; and, considering the disparity which exists between him and his readers in extent of knowledge and modes of thought, it would have been impossible for him to have performed this portion of his task more efficiently than he has done. Indeed, there is no need for any qualification in our approval; and we are only doing him justice when we say that the combination of popular phraseology with accurate scientific information has never been surpassed, perhaps not equalled in any similar course of scientific lectures of a popular character that has come under our notice.

The mode in which the reader (or hearer) is enabled to carry away with him a simple, yet accurate ideal of the animal frame; and the familiar similes whereby the functions of the living creature are impressed upon the mind are above all praise. In fact, whenever the author attempts to convey to his imperfectly educated hearers (we speak, of course, of their scientific education only) a knowledge of those phenomena in nature which are recognized as *facts*, he does so with admirable tact, and in nearly every case with undeniable accuracy.

Had he confined his labours within these limits, and simply proposed to himself to make his readers and hearers acquainted with the phenomena of nature as they *are*, our criticism would have ended here;

but unfortunately he has not done so; and as his fame and position preclude our passing over the inaccuracies in his work with a brief comment or laying it aside altogether, we have no other alternative than to deal with its defects as with its merits. This we will endeavour to do as fairly as we are able, not confining ourselves to a mere expression of opinion as to what appears to us inaccurate or inconsistent, but endeavouring to point out where the error lies, and where the argument yields under investigation.

It would be almost impossible, in this criticism, to sever the author's views concerning the laws of nature from those of Mr. Darwin. Not that we consider them identical, but the author seems to believe that they are, and would have us think the same; so he has written his book accordingly.

To some extent, no doubt, their views are identical, and in one important particular they may be considered completely to coincide. Both believe that the formation of a new species in nature is the result of the gradual modification of some other species (that each is not a special creation); and that the operating cause is the conjoint action of what the author calls "atavism* and variability," and the various conditions of existence in which the animals are placed; in fact, they believe that the production of *varieties* and the perpetuation of *races* are due to inherent tendencies or properties possessed by the animals themselves, and by the external conditions by which they are surrounded; and then extending this principle further, they believe in the formation, by this mode, of *species*, *genera*, &c.

This is the doctrine of Mr. Darwin. But our author is not content to be a teacher, a mere repeater of the theory of another: he takes upon himself the duty of a guide and critic, and tells us that, before we accept any new theory of this kind, we ought to subject it to the most searching scrutiny; thus constituting himself our guide, he proceeds to lead us accordingly.

We should not, he says, reject this or any other hypothesis merely because we are told that it is not in accordance with the Baconian philosophy, but we should deal with it as we would treat any question in common life. To enable us to do this, he gives, in one portion of his work, numerous illustrations of the kind of treatment of which subjects of this kind are susceptible, selecting one example in particular that appears to him to be peculiarly applicable to the solution of the problem connected with the production of a new species; and in a later discourse, he lays down with more precision the rules by which, according to his views, the accuracy of Mr. Darwin's hypothesis should be tested.

"The method of scientific investigation," he tells us, "is nothing but the expression of the necessary mode of working of the human mind;" and, as an instance taken from common life, illustrative of the method by which phenomena may be attributed to their true causes, he mentions the case of a man who, having left some plate in his parlour over night, comes down the next morning and misses it. Seeing that the window is open, he inspects it, and finds the mark of a dirty hand on the window-frame, and subsequently the impress of a hob-nailed boot outside on the gravel. Of course, he suspects that his plate has been stolen, and the *hypothesis* is that the owner of the dirty hand and hob-nailed boot is the thief. Undeterred by the counter-hypothesis of some kind friend, who suggests the possibility of the laws of nature having been "suspended during the night," and that there might have been "some supernatural interference in the case," he calls in the aid of the police, who track the burglar with the property on his person, and find that the marks correspond with his hands and boots. Under such circumstances, he thinks a jury would verify the hypothesis by convicting the prisoner.

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* Hereditary similitude (from *atavus*, ancestor).

After showing that it was by such hypotheses that Newton and Laplace made their discoveries, and telling his readers that the value of the result of the hypothesis depends upon the pains taken in its verification, he proceeds to say that it is on this inductive method of inquiry he means to consider the state of "our present knowledge of the nature of the processes which have resulted in the present condition of organic nature."

The precise bearing of this anecdote to the point at issue is not given with the story itself, and we shall inquire how far it is applicable to the natural problem before us; supplying what appear to us to be deficiencies, which might not occur to the "working classes."*

The Story:—

1. A gentleman misses his plate, and asks himself what has become of it.
2. He finds evidence of a man having escaped from the window.
3. From this evidence he concludes, or rather forms the hypothesis, that a burglar had stolen his plate, and has escaped from the window; and determined to be guided by this hypothesis, he directs his investigations accordingly.
4. On proceeding in his investigations, he finds the burglar with the property on his person, and has him convicted.

The Moral:—

1. A naturalist observes that certain groups called species are related together by structural and functional peculiarities; and he asks himself how these species have originated.
2. He finds that by artificial breeding or selection, man is able to form varieties and races; and that similar influences to that exercised by man are all at work in nature.
3. He conceives the idea of natural selection; and assumes that "species" have thus originated.
4. *To be complete, the moral should conclude thus*:—He investigates the operations of nature; finds species formed by natural selection; and thus realizing his hypothesis, he arrives at a satisfactory solution of his problem.

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* At p. 137, the author specially refers to this anecdote as constituting a case analogous to the one at issue, namely, the causes of origin of new species.

This we presume should be the *rationale* of the story; but is it so?

It is very easy to frame a suppositional argument, carry it to a satisfactory conclusion, and leave the reader to infer that it is precisely analogous to another that is hypothetical; but the author cannot be surprised if his readers, finding that his analogy does not hold good, should throw away his whole *theory* as worthless; and we fear that with many it will be so in the present instance. We have no objection to handle the inquiry after the author's own approved fashion; but we trust he will not object to the introduction of a little fresh evidence and one or two additional witnesses. As it is a serious case, too, and affects the liberty of the subject (for he sentences his man), we hope he will allow us to employ counsel, on our granting him the same privilege. We, too, shall put an hypothesis.

His "objector," who happens to visit him in his trouble, endeavours to dissuade him from calling in the assistance of the police, and does so on the ground that as the spoons were taken away at night, the possibility is that the laws of nature might have been suspended at this season and that there may have been some supernatural interference in the case, into which it would be presumptuous in the owner of the spoons to inquire.

We presume that this means, that as species originated before man appeared on earth, or before the beginning of the historic record, therefore, it is possible that the laws of nature were different then to what they now are; that species were supernaturally created; and it would be presumptuous in us to inquire into their origin.

We will now introduce another witness and a fresh element into the inquiry, the nature of which will be fully comprehended from what follows.

Another friend who happens to enter the room just as the owner of the stolen spoons has pushed his first friend aside, and is about to depart in search of the police, and hears what has happened, stops his exit, and says, "Softly, my friend; I don't put so much faith in the reversal of the order of nature as does your friend there; but don't be hasty: you are very much agitated in consequence of your loss; and, perhaps whilst you are running off in search of the police, the thief may be down stairs cleaning your boots, and he or she may take the opportunity to secrete the plate. Just let me see the marks on the window." And it is possible that when he comes to the window, his friend might say, "My good fellow, I always knew you to be an excellent leaper; but you seem to think there are better than yourself in the world; for this window is at least thirty feet from the ground, and if the thief did not fall into the area and break his neck, he would certainly be impaled upon the spiked railings beyond. Have you ever tried the experiment yourself?" Now we can imagine our friend of the stolen plate a little puzzled at first, but replying with great confidence: "Well, not exactly; but it occurs to me that a friend of mine, a much more active man than I am, once tried to get down into the garden, and he succeeded after endless labour and risk in reaching that ledge which projects from the wall about half way down. He came up again and expressed his conviction that the remainder of the descent was feasible also,—and so with your permission I shall go for the police." Well, we may tell our readers frankly that we think this person was very hasty, and would have done better if he had looked about in his own house, and had sent the most trusty of his servants to seek the police at the same time. We apprehend that if he found a burglar, or a man of notoriously bad character, with the plate upon him, there could be no doubt as to who was the thief, without either the evidence of the dirty hands or footmarks in the garden; but thieves do not generally carry stolen property about with them, especially when it is as heavy as silver plate is usually supposed to be; and we must beg our author to let us presume that the plate was discovered at a pawnbroker's, and that a man with dirty hands and hob-nailed boots was found, whom the pawnbroker believed to be the person that pawned the plate. Now we anticipate that the jury would like to be satisfied—

1st. As to whether this was the man who left his marks on the window.

2nd. Whether the pawnbroker was correct as to the identity of the thief.

For it is just possible that the actual thief may still have been in the house, and may have employed him of the dirty hands and hob-nailed boots to pawn the property for him.

Let us follow the owner of the property. We suppose that although he might think the evidence perfectly clear, he would entrust his case to counsel, and the professional gentleman, not being the victim of the theft, would naturally inquire into all the circumstances, and, amongst others, would hear of the height of the window from the ground; so, too, would the counsel for the defence. But, as our readers know, it is the duty of a barrister to make out his case, and upon his ability to do so under difficulties depends the success of his client. Well, we can imagine the prosecuting counsel being very much puzzled to connect the marks left by the man with the man himself, and endeavouring to get over the difficulty by some such pleading as this: —

"Every portion of the evidence, gentlemen, is quite clear, excepting one link; and this there is good reason to believe is much more tenable than it appears, for a friend of my client once succeeded, though with some difficulty, in getting upon the ledge half-way down, and he has been consulted, and repeats what he said at the time of his experiment, *viz.*, that he is satisfied the thing could be accomplished. My client, who is a clever gymnast himself, thinks the same. And I defy my learned friend, the counsel for the prisoner, to show that it was impossible for the prisoner to have effected his escape to the ledge, and from the ledge to the ground. *We* don't pretend to explain *how* it can be done, but we see every reason to believe that it is possible, and unless my learned friend can prove the contrary, I argue that the *jury* has no other alternative than *to commit the prisoner!*"

Now it appears to us that the best course for the defending counsel to adopt would be to leave the evidence precisely where it stands; and not even to avail himself of the arguments used by the objector on the ground of "supernatural interference," in the hope that some of the jury might be "orthodox;" for we have little doubt that the prisoner would be acquitted without much consultation on the part of the jury,—in fact, the verdict would be "Not proven."

This, as it appears to us, is precisely how the question of the "Origin of Species" stands at present. The chief obstacle which now stands in the way of the acceptance of Mr. Darwin's theory is, that he has not been able to create a new species by artificial selection. Although he has effected in a few years an approach to that end which, *in nature*, would probably have occupied ages; and although he and others have produced 150 varieties (of pigeons), differing widely from one another, yet in every case these varieties have been fertile with one another, and there has been no approach to sterility.* Neither can it be shown that "*natural* selection" is anything more than a probability, nor that, in nature, species have been found to cross, excepting (as a general rule) with sterile results.

This is of course the chief interpretation of our supplementary evidence concerning the height of the window from the garden. And now as regards our author's special pleading. If any one thinks that we have overstated or burlesqued this part of the subject, let him turn to the text,† and there he will find how ingeniously, nay, how plausibly, the author disposes of the difficulty in question, really the crucial test.

The author's argument is practically as follows. We will test the validity of Mr. Darwin's theory by a three-fold process:—

1st. We will ask: Do the supposed *causes* of the phenomena exist in nature?

The answer is decidedly affirmative. Atavism, variability, and conditions of existence analogous to those which are operative in artificial breeding, *do* exist in nature.

2nd. Are these causes competent to produce new *species*?

Answer, not quite so confident. *Races* may be thus produced, and it would be very difficult to explain many of the phenomena connected with species in any other manner.

(Is it possible to reach the ground from this window?

Yes; a friend of mine has succeeded in reaching the projecting ledge; besides, there are many circumstances connected with the theft—dirty hands, &c., which could not be otherwise explained.)

But I grant freely that, so far, it has been found impossible to produce infertile hybrids by artificial breeding, and being a *disinterested critic*, I feel bound to confess that it is a serious barrier to the acceptance of the views which I advocate. Still the phenomena of sterility are very capricious. The crucial test *may* be successfully applied, and unless *you* can prove it to be *impossible* you have no right to say it cannot be effected, and to deny the accuracy of my theory, which assumes that this is the normal method by which new species have been produced.

(There is no knowing whether some day or other a person may not manage the leap from the ledge to the ground; and unless *you* can prove that it is an absolute impossibility, you have no right to say that my plate was not stolen by a burglar, who, I believe, *did* effect his escape in this manner, and in justice you ought to transport the man.)

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* This will be more fully explained hereafter. † P. 137.

But we have not the space, nor is it needful, we think, to follow the author further in his reasoning. It may have appeared very clear to the "working classes," but it has not satisfied us that there is no alternative between "Darwinism" and "nothing."

Perhaps as we do not ask our readers to bring the "Baconian philosophy" to bear upon this inquiry, the author will allow us to draw their attention to a more modern method of treating this and all similar questions.

Induction, we have excellent authority for saying, "consists in stating the facts and the inference in such a manner that the evidence of the inference is *manifest;*" just as the logic of *deduction* "consists in stating the premisses and the conclusion in such a manner that the evidence of the conclusion is manifest." We suspect that if our authority for this definition* had read these lectures, he would have added, by "*the facts*, I mean all the known facts of importance." In the first case (the story) our author has not stated *all* the facts as they exist, but has assumed some which do not exist; in the second (his logical inquiry) he has glossed over the *importance* of the fact previously omitted, and instead of proving the case has thrown the burden of *disproof* upon his opponents.

But now we come to another inquiry. Does the author accurately state Mr. Darwin's views and inferences concerning the causes of the phenomena of organic nature, and is the author's testimony sufficiently unbiassed to warrant persons who are uninformed on scientific matters in taking him as their guide on the subject? We do not for a moment doubt that he is perfectly sincere in his enunciation of Mr. Darwin's views; but our readers shall also have an opportunity of forming an opinion on the matter, and of judging for themselves as to whether it is best to seek their information at the main stream, or to judge of its proportions from those of its tributaries.

And perhaps it will be better that we should not confine ourselves to the exposition of Mr. Darwin's views coming from a warm advocate; but that, as the opportunity presents itself, we should also lay before them those of an opponent, and they will be somewhat astonished to find how the teachings of the great naturalist have been made the key-note to any melody.

In reviewing a work of a kindred nature to the one before us,† and written by one who also wishes to be regarded as an unprejudiced witness, we deprecated *very mildly* the introduction into such inquiries as these of the *odium theologicum*, in consequence of a charge of materialism brought against Mr. Darwin by the author. He passes sentence upon that eminent naturalist by saying that his theory is "a blind chance process," resembling that of Lamarck, or the author of "The Vestiges;" indeed, he

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* Dr. Whewell.

† Page's "Past and Present Life of the Globe." Blackwood. Reviewed in "Popular Science Review," No. I.

(Mr. Darwin) merely phrases "in different terms the same materialistic hypothesis." He adduces his evidence in a foot-note, in which he says that in "the whole tenor of the 'Origin of Species' there seems to be a studied non-recognition of any higher influence than chance, external conditions, nature, law, and other kindred activities." In other words, he says that Mr. Darwin is a materialist, who ignores the existence of the Deity; and that the whole tenor of his work shows this to be the case. We will return presently to the statements of this gentleman, who is "*guided solely by a desire to arrive at Truth;*" and who wishes to "*deal charitably towards the opinions of others;*" and will pass on to those, not of an opponent, but a warm partisan—the author of the work under criticism.

Speaking of Mr. Darwin's theory:—"As I apprehend it," says our author, "for I have put it into a shape more convenient for common purposes than I could find *verbatim* in his book; as I apprehend it, I say, it is that *all the phenomena of organic nature, past and present,** result from, or are caused by, the inter-action of these properties of organic matter which we have called Atavism and Variability, with the Conditions of Existence; or, in other words, given the existence of organic matter, its tendency to transmit its properties, and its tendency occasionally to vary; and lastly, given the conditions of existence by which organic matter is surrounded; that these put together *are the causes of the present and past conditions of organic nature.*"

Judging from the remarkable similarity between these two versions of Mr. Darwin's theory, our readers might be disposed to think that both writers must be correct—the opponent, who stigmatises him as an atheist, or something akin to it; and the advocate, who appears to endorse his views. But we will now let Mr. Darwin speak for himself:—

> "I *believe* † that animals have descended from at most four or five progenitors, and plants from an equal or lesser number. Analogy would lead me one step further, namely, to the belief that all animals and plants have descended from some one prototype. *But analogy may be a deceitful guide.*"‡ . . . (After showing that all living things have certain properties in common) . . . "Therefore I should infer from analogy that *probably* all the organic beings which have ever lived on this earth have descended from some one primordial form, *into which life was breathed.*"

Again:—

> "Authors of the highest eminence seem to be fully satisfied with the view that each species has been independently created. *To my mind it accords better with what we know of the laws impressed on matter* BY THE CREATOR *that the production* and extinction of the past and present inhabitants of the world should have been due to secondary causes, like those determining the birth and death of the individual."||

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* These italics are our own.

† Here also the italics are ours.

‡ Origin of Species, p. 484.

|| Ibid. p. 488.

And thirdly :—

"There is a grandeur in this view of *life* with its several powers, *having been originally breathed into a few forms or into one;* and that whilst this planet has gone cycling on according to the fixed laws of gravity, from so simple a beginning, endless forms most beautiful and most wonderful have been and are being evolved." *

The author first referred to, who declares himself to be the seeker of "truth," and who wishes to deal "*charitably* towards the opinions of others," has in his work quoted the last extract, in which our readers will perceive that the Creator is *referred to*, but not named; but he sedulously avoids noticing the second paragraph, which he might have found (if he did not find it) on the preceding page; and although he condescendingly gives Mr. Darwin credit for *geniality*, as evinced in the paragraph last quoted, and the context; yet he condemns him for appealing to *chance* and *nature* (not to *prescience* and *Almighty Power*, mark!) for all subsequent development, "as if these blind deities † were aught without the direction of the same original life-breathing impulse!" *Ergo, Mr. Darwin is a materialist.* Now, without expressing our individual opinion (which may or may not, for causes other than those under consideration, be at variance with Mr. Darwin's), we would ask our readers to say honestly, who has formed the highest conception of the Creator, he who believes that the Deity said, "Let it be," and so it is for ever; or he who believes that the command is *of no avail* unless the Lawgiver watches for ever over the execution of His laws, lest they should vary or be broken?

As to the misrepresentation, we say nothing. Our readers well know how to value the testimony of such a witness for the future. One thing is quite certain. A proceeding of this kind is by no means calculated to enforce a recognition of the hand of the Creator in His works.

But if this writer has misconstrued Mr. Darwin, we think our readers will agree with us that Professor Huxley has been far from happy in *his* interpretation of the views of that eminent naturalist, and that neither commentator has conferred a benefit on the object of his criticisms.

Mr. Darwin does *not* say, "given the origin," or "given the existence of organic matter, its tendency to transmit its properties, &c." . . . . "these are the causes of the present and past conditions of organic nature."

What he does say, we have given in his own words, and it is unnecessary to repeat them. He modestly expresses his conviction in a certain theory in regard to the production of all species, past and present, from a few forms, and draws attention to the fact that the same reasoning might lead to the belief that all are descended from one prototype. He shows that the phenomena which form the basis of his belief are due to secondary causes; but he has taken care to let his readers distinctly understand that he has never lost sight of the Great First Cause, speaking with becoming modesty and caution of the laws which he sees operating in nature, and only approaching the Lawgiver with reverence at the conclusion of his labours to pay him his tribute of praise in what appears to him to be the most fitting manner. His interpreter, or critic, whichever our author claims to be, whilst he confounds the naturalist's inference as to what is *probable*, with his belief, founded upon actual observation, concerning secondary causes, totally ignores the author's reference to the First Cause.

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* P. 490.

† There is nothing in Mr. Darwin's work to warrant this expression: "These obedient servants" would have been correct.

Mr. Darwin addresses the world of science; and he does so, as we just observed, modestly, cautiously, and with due regard to the difficulties that militate against the acceptance of his own theory. *In fact, he is by far the fairest critic who has ever dealt with the views that he himself has propounded.* His interpreter to the *working classes*, and to many very young students, harangues these with great ability, and with unbounded confidence in his own opinion concerning all that his author believes, and all that he supposes him to believe in regard to secondary causes; but in his address he completely ignores his reference to the Creator.

It is about seventy years since a remarkably able French naturalist, Lamarck, drew attention to what we may call the "theory of progressive development" in the animal races; but his method of explaining the visible phenomena has not been deemed satisfactory. He was unable to show "experimentally that even races could be produced" as *he* supposes species to have originated. Now another naturalist, of equal ability, has shown that, under certain conditions,* races *can* be produced artificially; but he has not been able to evolve a new species from a variety, and his theory is admitted by himself to be imperfect. On this second attempt to solve the mystery of nature, our author steps forward and says to the masses (many of whom have never before heard the name of Lamarck mentioned), "Lamarck was a speculator (not quite such an objectionable one as some one else whom he names) and his theory has pretty well dropped into oblivion, as it deserved to do. Put him on the shelf, and if persons tell you that Mr. Darwin is groping towards truth as he did, I won't instruct you what to think of their judgment, but will leave you to think what you like, and *believe in Darwin*. 'Darwinism, or nothing,' is my motto —to-day—but, mind, I don't pledge myself to him, and should anything turn up to-morrow, that appears to serve our purpose better, I shall come and tell you so." We confess we cannot hold our beliefs with such a "light hand," and "part with them as cheerfully" as does the author, "the moment they are proved contrary to fact, great or small," and we repeat, that for the present, we prefer Nothingism to "Darwinism." Thus, at least, we shall retain our judgment for any emergency that may arise hereafter.

Whilst referring to "isms," we cannot refrain from mentioning that there are expressions in the work before us which are calculated to bring it into connection with an "ism" of a most unenviable kind, and the author and our readers shall judge for themselves whether or not we are right in saying that they are *ill-chosen*, in addressing the "working classes." In speaking of the limits of human inquiry,* he says, that all our knowledge and all our investigation cannot take us beyond the limits set by the finite and restricted character of our faculties (a declaration, by the way, *hardly* in accordance with what he has said of man elsewhere†), "or destroy the endless unknown which accompanies, *like its shadow*, the endless procession of phenomena."

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* To understand this question properly, and judge of the difference ween the views of Lamarck and Darwin, the reader should carefully der both, as there are similarities between them which do not appear ace.

Let it be clearly understood that we do not, even by inference, desire to bring the grave charge against our author, which is so thoughtlessly bandied about by the ignorant or bigoted, a proceeding which we have ourselves deprecated in another; but we repeat, that this and similar expressions are *ill-chosen* in an address to the working classes.

And now, turning again to facts. Mr. Darwin has very properly said that there are "many and grave objections" which may be advanced against his theory; but we must add that there are also many striking facts which point to the special formation of new species from varieties—but not under the conditions and through the agencies attributed to Nature by Mr. Darwin.

In treating of the *origin* of varieties, Professor Huxley speaks of the birth of a six-fingered human being, and also of the production of a remarkable variety of sheep. These cases the author refers to "spontaneous variation," but he is so wedded to his adopted theory, that they do not suggest to him anything beyond chance. They are "accidental variations." This may be so, or it may not; but we will grant that it is so. Is there nothing to be learned from the *first appearance* of these "monstrosities?" If "Darwinism" be unable to account for these mysterious apparitions in nature, may they not serve as a clue to something higher than "Darwinism?"

Apparently the six-fingered man is really a monstrosity—and his appearance proves nothing more than that an unprecedented and apparently inexplicable change may take place in nature, and what the author would call an abnormal feature may appear to be perpetuated.

Of the long-bodied, bow-legged sheep, it can hardly be said that it was a *monstrosity*,—if so, it was a most convenient one to its owner, for it was just as useful to him as if he had *designedly* made such a sheep! Monstrosity or not, it was a very useful variation in the breed, with which (as far as evidence shows) neither atavism, variability (strictly speaking), nor the conditions of existence, had anything to do; yet it was remarkably adapted to the requirements of its owner and to the conditions in which he found it, and he therefore proceeded at once to perpetuate its peculiarities and form a new race. If we are to reason from art to nature, or, more correctly speaking, from the human to the Divine, then we have here a clue to the mode in which a new species *may* have been brought into existence when circumstances required it. The *type* is here created in complete adaptation to external circumstances, and is then, by external conditions (the hereditary transmission of peculiarities, &c.), perpetuated as a race.

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* P. 135.

† "Natural History Review," No. I. (1861), p. 67, line 22, "The only earthly being of *practically unlimited* powers."

We recommend to the earnest consideration of our author the question of "spontaneous variation."

Pasteur's experiments can hardly be said to have given the *coup de grace* to the theory of "*spontaneous generation*,"* for some months before the author delivered these lectures, Professor Wyman, of Boston, had published his experiments (which were a repetition of those of Pasteur), with precisely the opposite result at which the French chemist had arrived. And, moreover, if *man* succeeds in making a living protozoon or protophyte out of inorganic substances,—a possibility which, according to the author's views, may be realised before fifty years have elapsed,—this "direct method" will be the strongest evidence that the Creator still continues to supply the earth's surface with the germs of these lowly forms through the operations of nature; for where are the necessary conditions the most likely to exist?—most certainly in nature, according to the author's view of the Darwinian hypothesis.†

Speaking of Professor Wyman, we do not exactly see the applicability of the author's reference to that gentleman's anecdote of the "Paint-root" and the "black pigs," with regard to natural selection.‡

The argument is that the most minute cause will sometimes save a species from extermination, and a case of "selection of colour" is here mentioned; namely, that in a locality where a certain root grows in Florida it has killed all the *white* pigs which have fed upon it (their hoofs cracking before death), whilst to the *black* pigs it is innocuous; consequently black pigs only are to be found there. Are we to understand that the black *colour* of the pigs is the "minute circumstance" which saved their lives? We cannot read it otherwise; yet it appears to us highly probable that the colour had nothing whatever to do with the phenomenon, but that it was only an unimportant concomitant of some very important difference between the two kinds of pigs, of which the narrators (the inhabitants) were ignorant. There are certain substances which act as poisons if taken by the lower animals, but are harmless to higher forms of life. This we presume is due to some very important physiological difference between them; and is it not merely an extension of the *actual* (not the alleged) cause that saved the black pigs?

Geological and Palæontological Records.§—The author tells us that in these records there can be no cavilling, as in the histories of human origin "Nature's records," he says, "are laid clearly before us, and the facts state themselves; the question of the credibility of the natural record will require but little consideration.

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* As stated at p. 82.

† It must not be understood that from this we advocate the theory of "spontaneous generation;" we are simply considering it from the author's point of view.

‡ Pages 130, 131. This is Mr. Darwin's argument.

§ Page 31, et seq.

We are at a loss to know why this statement was advanced by the author. It leads the reader to suppose that there can be no quibbling in regard to geological or palæontological evidence, but the sequel shows that not only is that evidence very scanty, but what there is of it is liable to extreme misinterpretation. He even goes so far as to say that if man had access "to every part of the earth (instead of only to 'about the 140,000th part of the accessible earth'), and had made sections of the whole, and put them all together, even then his record must of necessity be imperfect."

The fact is that the records of nature pretty much resemble those of man; and a comparison of the two records is calculated to impress even the most sceptical with the wonderful unity and all-pervading influence exercised by that Eternal Mind, which is gradually initiating us into the mysteries of nature, and instructing us in regard to the history of the universe.

In the world's physical history we have certain grand, well-defined eras: and so also in the history of our race. Strata, whose characters are unmistakeable stand side by side with dynasties and empires, regarding which we have an extensive fund of general knowledge. How long the strata were in arriving at their present state, or for what length of time they were uppermost, is at present very doubtful; what numbers of centuries the empires or dynasties were dominant, or the period which elapsed between their rise and fall, is in many cases equally debateable.

So, too, we have well-marked records of the animals which inhabited the globe during the depositions of the various strata; and their remains enable us to reconstruct and vivify and compare each group with its predecessors, or with those that succeeded them. The same obtains in human history, where sepulchres, mummies, hieroglyphics, arms, implements, and other antiquarian treasures are the indestructible traces which enable us once more to recall the different peoples to life, and to study their character and instincts. In both classes of facts our knowledge is daily increasing, and no one can with justice say that one record is more reliable than the other, nor predict with safety that "all human knowledge must stop somewhere."

When the author gives a "practical" definition of "species" (one, by the way, which is very convenient for his argument), and falls back completely upon structural differences; and when he states that "whether a physiological test between species exist or not, it is hardly ever applicable by the practical naturalist;"* he should remember that as his definition was derived from animals "in a state of nature," it is only right to ascertain whether or not Nature herself applies a test of species. Or, to speak more plainly, whilst he was careful not to omit the mention of any evidence which he could find in artificial breeding, or in nature, to show that animals might be and have been produced by his process of selection, which differ from another so widely in their *structure* as to constitute *apparent* species, would it not have been fair to such of his readers and hearers as are uninformed on the subject, to lay stress upon those *obstacles* presented by Nature herself to the amalgamation of *acknowledged* species? Is it not a fact that the higher animals are endowed with instincts (*functional* attributes so to speak) which act as a repelling influence between species and prevent them from breeding *at all*,* and are not the lower forms of existence (such as insects) actually furnished with appendages, *structural* peculiarities, which render a fusion of species *absolutely impossible?*

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* P. 109.

Indeed, leaving the domestic animals out of the question, and putting that stock-example the Rock pigeon aside for a moment, we would ask our author whether there is any property of "species" in nature, any one of its numerous designations so prominent and immutable as the physiological bar to cross-breeding. This may or may not affect the question at issue, but when the author dwells upon the "capricious character of sterility," and rakes up all the evidence he can find in favour of a theory which he is subjecting to a "critical examination," it appears but just to his hearers to tell them not only what is abnormal, but also what is almost the undeviating rule in nature. For after all it must be remembered that Mr. Darwin seeks to prove that new species have been found in *nature* and by *natural* selection; and even if he produces a new species by artificial breeding, "analogy may be a deceitful guide."

And now, finally, we come to the question of Man; a subject which we approach with "humility and hesitation" akin to that which the author experienced when he dealt with the "great art and mystery" of pigeon breeding, and one upon which in all earnestness "a man must not speak lightly."

The author believes that man is an improvement from some lower animal; but in this he tells us that he is expressing not Mr. Darwin's, but his own view; and he proceeds, popularly and very briefly, to communicate to the masses his well-known opinions on this subject.

Here, again, we confess ourselves greatly disappointed. There can be no doubt that the author carries with him the approval of a large number of the leading physiologists of the day in his views concerning the alleged *structural* differences between man and the ape; but from the illustration before us we should say that it is an easier task for him to pull down an edifice than it is to build it up afresh with the old materials.

Man is no longer to be judged by structural peculiarities, he tells us; and first he proceeds to drive his opponents out of the field before installing himself in their place, and introducing a new *régime.*

He has been asked, he says, how he accounts for the vast intellectual difference that exists between man and the ape, as compared with the almost imperceptible structural variations between them; whilst at the same time he affirms that all functions—intellectual, moral, &c.—are the *result of* structures.

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* We lay stress upon these words, because the author does mention that the results of an intercrossing of species produces different results (when it occurs) to that of varieties.

Here is the reply :—

There is a great misconception as to the "real relations which exist between structure and function, between mechanism and work." Although one is related to the other, function being "the expression of molecular forces and arrangements," yet it does not follow that one must keep pace with the other; and if it could be shown "that a variation in function which follows on a variation in structure may be enormously greater than the variation in structure, then, you see, the objection falls to the ground."

But of course this is an "hypothesis," and one which, it might be thought, could easily be proved by natural phenomena in the same manner as the Darwinian hypothesis. The author, however, prefers having recourse to the mechanical world for his evidence, and proceeds to tell his hearers that he will take two watches, "made by the same maker, and as completely alike as possible, and, laying them side by side, will set them going." He then, with the aid of a pair of pliers, "just lightly crushes together the bearings of the balance-wheel" of one of them, and the watch so treated will cease to go. Thus, he says, a "slight structural alteration" leads to "an infinite difference in the performance of the functions of these two instruments."

Passing from mechanical art to the natural world, he says that it is the power of speech which makes man what he is; that a slight imperfection or derangement in his organs of speech would make man dumb; that "a race of dumb men, deprived of all communication with those who could speak, would be little indeed removed from the brutes;" and that "the moral and intellectual difference between them (such men) and ourselves would be practically infinite, whilst the naturalist would not be able to find a single shadow of even specific structural difference."

The author has expressed such contempt for "inductive and deductive philosophy" (and perhaps with justice, in speaking to the working classes), that we feel almost disposed to follow his directions and weigh his argument, as he endeavoured to test Mr. Darwin's hypothesis—namely, by analogies in every-day life. But we have no more space for long stories, so we must be excused if we in this instance revert to the old system, and thus endeavour to ascertain whether the reasoning is sound and conclusive, and whether the propositions are based upon facts.

This appears to be the author's argument :—

1st. Slight variations in structure may produce immense differences in the accompanying function, which is the expression of structure.

2nd. Of two watches made exactly alike, you may stop the function of one (which function is its rate of going) by slightly altering its mechanism. *And, again*, speech is the function which distinguishes man from the brutes, and speech is the result of a slight structural attribute, which, being deranged or rendered imperfect, induces dumbness.

3rdly. Therefore, a trifling difference in the structure of man (the imperceptible change which might be caused in his glottis) is followed by an infinite variation in function (speech or dumbness, as the case may be, and its results).

As in the former case, the argument may seem clear and conclusive to our author; but it is not so to our apprehension.

The first proposition, which it is unecessary to repeat, is denied by his opponents, or rather he undertakes to prove its accuracy, and that he seeks to do in his second. But his second does not appear to us to consist of facts, for in dealing with the watches he neither brings about a structural alteration, such as he requires for his argument, nor does that alteration result in a variation in functional *action* (for that is the point at issue). He simply *injures* the mechanism, and completely arrests, or destroys, its functional action. If the author had shown that by effecting some imperceptible change in the mechanism of one watch, he could make it go *immeasurably faster* than the other, then his simile would have been appropriate; but we could not have accepted it as evidence in favour of his argument. It would *then* only have been a simile; but as it now stands, it is not even a pertinent one. Had the author told us to place by the side of these watches two men made by the same Maker, and as completely alike as possible; and that if we or the Maker (the Maker in preference, as He understands His handiwork the best) were to derange some minute vital organ, he would cease to live, and that all his vital functions would be stopped, we should have said that the analogy holds good, and should have seen in it an evidence of the feeble tie that unites body and soul. But as it stands, it does not bring us a step nearer to a conclusion, being simply irrelevant, and we must pass it by; and proceeding to the natural illustration, man's speech, we take exception to it on the ground that it assumes as a fact what is not so, namely, that it is speech which "constitutes and makes man what he is," &c.

In the first place, speech is a mere instrument of the mind; and, secondly, it is not by any means so infallible an instrument as the hand (aided, of course, by the chisel, the pen, or the pencil). It is certainly not tradition which has "enabled man to record his experience," and constituted him what he is at present. And, finally, it is very doubtful whether a race of dumb men, circumstanced as the author states, would be so degraded as he seems to think. Their progress would be slow, but their human attributes would not be extinguished by the absence of this one faculty.*

Now if these exceptions which we have made to the author's propositions be well grounded, he has simply failed (as far as his examples go) to prove that a "variation in function, which follows on a variation in structure, may be enormously greater than the variation in structure;" but if he had proved this exceptional law (and we apprehend that the author does not regard it as a *general* one), still we should have protested against its application to the nature of man, in the sense in which the author applies it; namely, that the advantage which he has over the lower animals in being able to speak, "constitutes and makes him what he is;" and we believe that in so doing we should have the approval of our readers; and perhaps, after mature consideration, that of our author.

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* We should add that precisely the same mode of treatment has been adopted by the author in dealing with his *men*, as with his *watches*. He does not bring about an immense variation in function; but, as in the case of the watches, he completely *stops* the functions of one of them.

In another place,* we thus endeavoured, in a familiar manner, to point out the characteristic which distinguishes man from the lower animals:—

> "The advocates of such theories as that of Darwin, and those who refuse to acknowledge some trifling attribute of man's bodily nature as a sufficient evidence to justify his severance from the lower animals, are even in this enlightened age branded as heretics and infidels, and the more charitably disposed speak of their doctrines in a fearful whisper. But is it not far more 'orthodox' to discard such trifling considerations, and seek the true characteristics of our race in those *mental* attributes by virtue of which man towers so high above his inferior companions on earth? Is not the power to write the name of his Maker a more obvious distinction than the 'opposable thumb' with which he holds his pen to perform the act? Are not the mental qualities that enable him to appreciate the beneficence of that Maker far more important attributes of his nature than any trifling peculiarity in the temporary and perishable organ by which his mind operates?"

In the same place, too, we referred with satisfaction to the opinions of one who claims a higher title to be heard on such matters than we do; and the particular expression which seemed to call for our approval was this:—

> "For whether, as some think, man is by his origin distinct from all other living beings, or whether, as others suppose, he is the result of the modification of some other mammal, his duties and his aspirations must, I apprehend, remain the same. The proof of his claim to independent parentage will not change the brutishness of man's lower nature; nor, except to those valet souls who cannot see greatness in their fellow because his father was a cobbler, will the demonstration of a pithecoid pedigree† one whit diminish man's divine right of kingship over nature, nor lower the princely dignity of perfect manhood, which is an order of nobility, not inherited, but to be won by each of us, as he consciously seeks good and avoids evil, and puts the faculties with which he is endowed to their fittest use."

In this definition of the nature of man, as compared with the lower animals, no reference is made to his organ of speech; but his characteristic attributes are found in the *mind*, and in his conscious power of discriminating between right and wrong. His prerogative is not any unimportant structural feature, nor yet his function of speech—it is his *moral nature*, and we accepted this definition from its author, Professor Huxley,‡ as an earnest of something nobler that was concealed in the background.

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* The *Times*, April 3, 1861. "Natural History," by John Hunter: a Review.

† *i.e.*, descent from the ape.

‡ "Natural History Review," No. I., 1861, p. 67.

But in the present work we seek in vain for the recognition of man's religious nature, and we are tempted to inquire whether the conviction of his "pithecoid pedigree" has, after all, entailed with it a less noble estimate of his character, in contradiction to the very principles laid down in the foregoing extract, and whether we are to understand that he is now hung up a little higher than the parrot and the jackdaw. We prefer, however, to abide by the old definition of years gone by, and to hope on for a recognition of his noblest attribute—his faith in, and reverence for, an invisible Creator.

And, finally, we must be excused if we indulge in a little personality, which is indispensable to a full statement of our reasons for having given such prominence to this little work.

Had it emanated from an ignorant fanatic, or from some unknown scribbler, who would seek through the enunciation of extreme views to obtain notoriety where fame was unattainable, we should have ignored its existence. But it is not so; and if we may judge by rumour—

> "A pipe,
> Blown by surmises, jealousies, conjectures,"

and not usually given to undeserved laudation, the author of this treatise is a gentleman who, through the affection which he inspires in his students (young men whose opinions will mould the fair form of Science, God's handmaid, in the future, and *to whom Mr. Darwin appeals for judgment on his labours*), through his generosity and kindness to rising men of his own profession, and through his daily increasing fame arising from his researches in the field of science, is likely to exercise a wide and permanent influence on every class of society. We should be undeserving, therefore, of the confidence to which we aspire, if we failed to direct public attention to what appears to us unsound reasoning in a work written by such a man, and directed to the particular class for whose instruction these lectures have been published.

Postscript.—Since the foregoing notice was concluded, we have received Professor Huxley's work on "Man's Place in Nature." We, of course, reserve our judgment on its merits until we have read it carefully. Meanwhile, we may mention that whilst the author employs more caution in speaking of Mr. Darwin's hypothesis in this later work, which is intended for scientific men and the general public, yet a hasty glance over its contents affords us no opportunity of recalling anything that we have said concerning the one here reviewed, which was specially addressed to the working classes.

MISCELLANEA.

SCIENCE ON THE CONTINENT.

New Methods of Engraving.—Efforts have been made in all directions to supersede the art of the engraver by mechanical and philosophical means, and many plans, more or less available, have been adopted or published from time to time; but M. Dulos, member of the Academy of Sciences, and engraver to the Imperial Board that has the charge of the roads and bridges of France, has recently made public a very ingenious system which he has practised for some considerable time. His process, to adopt his own words, is based on the following facts:—"If quicksilver be thrown upon a horizontal plate of silver or copper silvered, upon which any design has been traced with varnish, the mercury will dispose itself on the unvarnished portions of the plate and assume a convex form of a certain height. The same, as is well known, will occur when water is poured on a plate of ground glass on which a design has been traced with any fatty substance. In short, any liquid will act in the same manner, when brought into contact after the same fashion with substances for which it has different degrees of affinity."

The methods employed by M. Dulos are as follows:—For the production of an engraving to be printed by the copper-plate press, he produces the writing or design by means of lithographic ink, or chalk, or some other similar greasy composition, on a plate of silver or silvered copper; and then he deposits on the plate so prepared a thin coating of copper or iron, by the galvanic process, leaving, of course, the design uncovered. The ink or chalk is then removed by means of turpentine, and the design appears in silver, while the whites or interstices are represented by the deposited iron or copper. Mercury is then thrown on the plate and attaches itself to the silver only, and the excess being swept from the iron by means of a very soft camel-hair pencil, the design itself is represented by the convex surface of the mercury. A mould is then carefully taken in plaster or melted wax; the surface of this is metallized and casts taken from it, by means of the galvanic pile, which serve as the printing plates. For letter-press printing, the design is drawn on a copper plate, and a thin coating of silver is deposited on those parts not touched by the drawing material; the latter is then removed either by turpentine or ben
copper portions thus exposed are oxidized, and the ope
as before described. An intaglio plate may also
copper for the writing or drawing, depositing t
removing the ink or chalk and depositing
Another and apparently superior mode of

fusible metal mixed with a small portion of mercury, in place of the latter only; when this mixture is melted it acts in the same manner as mercury, and when cold the copper may be deposited directly upon it, and the necessity for the wax or plaster model, and copper matrix, done away with. The methods above detailed are not however suitable for delicate work, the removal of the excess of the mercury or of the fusible amalgam endangering fine lines. For superior purposes, therefore, M. Dulos makes uses of an amalgam of copper which he lays on a silver plate, upon which the design is already drawn, by means of a silvered roller which deposits the amalgam on the exposed silver portions of the plate, but leaves the iron coating entirely free. The Academy of Sciences has appointed a commission to report on these processes, and the result is awaited with considerable interest.

HELIOCHROMY.*—A recent report, by M. Niepce de Saint-Victor, to the Academy of Sciences, contains much matter of interest, not only as regards the photography of colours, but also in connection with the great question of the spectrum analysis. It is well known that yellow is the colour which presents the greatest difficulties to the photographer, and especially in heliochromy; but M. Niepce de Saint-Victor has at length succeeded, as he informs us, in producing the yellow tints with certainty, and in connection with other colours. Previously, he says, he could obtain red, blue, and green; but whenever yellow came, it was always by accident. The means by which he at length succeeded in reproducing yellow tints, was by the substitution of a bath of hyperchloride of soda in place of potash. The recipe given for this bath is as follows:—"Take fresh-made hyperchloride of soda, marking 6° of the arëométre, mix it with an equal quantity of water, and add alcohol in proportion of one-half per cent. of the soda; raise the mixture to the temperature of 70° or 80° centigrade (say 160° to 175° Fahrenheit), pour it into a flat dish, then plunge the silver plate into the bath for a few seconds, agitating the solution at the same time, until the plate assumes an almost black tint; then rinse it in plenty of water, dry it over a spirit-lamp, and warm the plate as much as necessary. A bath containing six or seven ounces of the solution is sufficient for the preparation of five or six quarter-sized plates. With plates thus prepared the colours are produced very brilliantly, especially by direct contact, and the blacks are often given in all their intensity. For the camera, M. Niepce de Saint-Victor recommends that the plates should not have too thick a coat of chlorate of silver, and that they should be of a fine cherry-coloured tint after being heated; he also says, that the plate should be covered with a varnish with chlorate of lead for its basis. As regards the fixing of the colours, M. Niepce de Saint-Victor announces, that he has succeeded in getting them to last a much longer time than he was formerly able to do, (but not yet in making them permanent), and the best means he has yet discovered for this purpose, is the tincture of benjamin of Siam, applied to the plate when the latter is warm.

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* The process of photography in which pictures are obtained in their natural colours.

After it is dry, the plate should be warmed again, in order to drive off a little of the benzoic acid. By these means, he says that he has been able to preserve the colours for three or four days, in an apartment fully exposed to a July sun.

That part of the memoir which relates to the different effects of the so-called primitive and binary colours is highly important. It declares all secondary colours to be decomposed in the process of Heliochromy; and in order to show the effect of light on a mixed colour, he selects green as affording the most remarkable instance. If, he says, the green be natural, such as that of the emerald, of arsenite of copper, of oxide of chromium, of sulphate of nickel, of green carbonate of copper, it will be reproduced on the heliochromic plate; but if it be a mixed green, formed, for instance, of chrome yellow and Prussian blue, that of a fabric dyed with a similarly mixed colour, or of glass coloured by means of yellow and blue pigments mixed, then the product by the heliochromic process is invariably blue, whether produced by direct action or in the camera. Again, a light blue-coloured and a light yellow glass placed together produce a fine transparent green; but whatever be the period of exposure, and however the glasses are placed, whether the blue be above or below, or even if it be imprisoned between two yellow glasses, the result is invariably not green, but blue.

In like manner, a red and yellow glass placed together, produce an orange colour when held up to the light; but they uniformly give red only to the heliochromic plate: a red and blue glass in combination produce at first a violet colour on the plate, which is of itself red, but it soon changes to blue. Paper coloured green by means of the leaves of trees, or by the *vert de vessie*, French "Chinese green" (extracted from the buckthorn), acts very slowly upon the plate, but eventually produces a greyish-blue tint, and the same occurs on attempting to reproduce natural foliage of a grass-green colour by means of the camera. But if the leaves are of a bluish-green tint, such, for example, as those of the dahlia, the blue produced on the plate is more decided; whereas, dead leaves, of a yellow or red colour, produce on the plate yellow or red, more or less pure, according to the absence of the blue matter which has been shown to give the green colour to foliage. The eye in the feather of the peacock's tail is well reproduced on the plate in the camera, the colour varying between blue and green, according to the angle of incidence at which the light is allowed to fall on the plate. This report seems to hold forth a fair promise, that should Heliochromy fail in its direct intention, it may afford valuable aid in the important inquiry into the composition of the solar spectrum, and in the evolution of a true theory of colours.

BONELLI'S PRINTING TELEGRAPH.—A governmental inquiry is now being made into this invention, which is in operation in England, and is said to be capable of printing 500 despatches of twenty-five words each per hour, an achievement which, it is admitted, would require, under the system in use here, twenty wires and fifty clerks; if the trials give a satisfactory result, it is said that M. Bonelli's arrangement will be at once adopted on the Paris, Lyons, and Marseilles line of railway.

NON-ARSENICAL GREEN PIGMENT.—The *Chemisch-technische Mittheilungen* contains an account of a new green colour. Dr. Elsner having had occasion to test a powder called *green cinnabar*, found that it was composed of prussian blue and chrome yellow, and reports that, although from the nature of the prussian blue it is not applicable for the painting of walls containing lime, or fit for colouring sweetmeats and other edible compounds, it is well adapted to supply the place of the dangerous arsenical green pigments used in paper staining, and may be produced in every shade, from the lightest to the darkest. The following is the method given for producing the pigment:—Mix together, in the first place, solutions of yellow chromate and yellow prussiate of potash; next take solutions of the acetate of lead and iron; mix these also together and then with the former compound, and a green precipitate will be produced, the tint of which will depend on the proportions of the various ingredients; the greater the quantity of the prussiate of potash and acetate of lead employed, the lighter, of course, will be the colour. The precipitate must be carefully washed and dried with a gentle heat. Dr. Elsner recommends the production of the acetate of iron by the precipitation of a solution of acetate of lead by means of sulphate of iron, and the filtering the residuary liquor.

The Effect of Syrups on Linen.—A French chemist has made some interesting experiments on the effect of syrup on textile fabrics. A piece of cambric was brought to him which seemed to have been burned by an acid, but which in fact had only had some drops of syrup of tolu dropped upon it. The chemist, M. P. Doré, tested the remainder of the liquid, and found it perfectly pure, consisting only of balsam of tolu, sugar, and water. He then dropped some of the same syrup on a piece of linen and dried it, and found to his surprise that it had rendered the fabric perfectly rotten. He sought for the cause of this apparent phenomenon, and came to the conclusion that it resulted simply from the rigidity given to the fibres by the absorption of the sugar. It is well known that frozen linen, or that which has been much starched, is brittle from a like cause. M. Doré says, that certain French weavers strengthen the threads of their warps by means of paste, but that as the effect would be lost by dryness, the unfortunate men are compelled to work in damp rooms and even in cellars.

Mechanical Perforation of Rocks.—A young engineer named Leschot, has invented a curious method of piercing rocks for mining purposes. Many attempts have been made in this direction, but with little success, and M. Leschot has hit upon the happy expedient of cutting out a solid cylindrical piece, instead of making his machine act upon the whole surface of the matter to be removed, thereby avoiding an immense amount of labour, and saving a vast deal of time. The new cutter is tubular, and its effect is to isolate a small column of the material, which can easily be removed by the action of a wedge. It consists of an iron tube whose outer diameter is equal to that of the required hole, and furnished with a steel ring carrying what may be called a crown of diamonds. The tubular piercer is made to revolve by machinery, and is at the same time pressed forward, making a circular incision in the rock, and the dust is prevented from accumulating by a current of water which is forced down the tube, and which at the same time prevents the heating of the cutter. That such a tool will make its way into a rock is evident; the question is at what rate and at what cost. The following are the particulars furnished on that head:—The power of one man, aided by a winch and gearing, is declared to be sufficient to cause the tool to enter hard granite, at the rate of about half an inch a minute; and one quarter of a horse steam power will, it is said, produce nearly double that amount of work. A cylindrical piece of granite, more than 10 inches long, and 1½ in diameter, is said to have been removed in 13½ minutes, leaving, with the portion cut away by the tool, a hole of nearly 2 inches diameter. As regards expense, it is stated that a tool will cut many yards of the hardest jasper or granite, without any apparent injury to the diamonds, which are of course of the commonest kind; the cost of the steel ring with the stones being originally little more than five pounds, while the value of the remains of the diamonds when worn down to the steel setting is given at about four-fifths of the original cost. The new drilling tool is now being put to a practical test in the mines of Saint-Chamond.

New Life-buoy.—This simple but ingenious arrangement for saving life and valuable property is the invention of M. Fonteneau, and has been reported upon most favourably both in England and France. It consists of a strong cask, having on one side a large trap, or door, made of bronze, and shutting down airtight by means of a screw, and on the opposite side a heavy piece of metal, to serve as ballast and keep the door always upwards. At each end of the cask are fixed strong iron handles or rails. In case of shipwreck, several of these life-buoys may be placed in the boats, or towed alongside, or used for the construction of a raft, papers and other valuables and provisions being placed inside. In the worst case, the bars at the end enable persons in the water to support themselves till help arrives. One recommendation of the new life-buoy is, that they cause no inconvenience on board ship, as they may be used as ordinary water-casks.

Soldering of full Water-Pipes.—The following ingenious contrivance is worth recording. A leaden water-pipe was broken by accident, and it was difficult to shut off the water; the plumber plugged the two ends, and then, having surrounded each with a quantity of ice and sea-salt, the water within the pipe was frozen solid in five minutes. The plugs were then withdrawn, the joint made, and in five minutes more the ice within was melted and the pipe in perfect condition.

Transplanting of Large Trees.—Sir Joseph Paxton and other English horticulturists were, we believe, the first who attempted, or at any rate perfected, the system of removing large trees from one place to another; but during the last few years it has been practised in Paris to an extent unknown elsewhere. At spring and fall the transplanting-trucks, or wheeled frames, are to be seen in all directions, and the Champs Elyseés, the Boulevards, and the various squares recently laid out in many parts of the town, have been adorned with thousands of noble trees by these means. A report was made on the subject the other day to the Cent Society of Horticulture, by which we are told, that horse-chest more than 39 inches in diameter, and a catalpa-tree 150 years old 23 inches in diameter, have been transplanted with success. Another very remarkable case is mentioned, namely, that of three good-sized tre growing in such a manner that they could not be separated, having been removed together from a private garden about to be destroyed, the mass of roots and earth measuring 5 mètres, or about 16 feet English in length.

It has been discovered, that the bleeding of trees and the attacks of insects, after the cutting off of branches, may be effectually stopped by the very simple method of well brushing the part exposed with a paste made of wood-ashes and water; the ash enters between the fibres of the wood and prevents exudation, while the alkaline property of the mixture keeps off the insects.

PRIZES OF THE FRENCH ACADEMY OF SCIENCES.—This branch of the Institute has recently announced its list of prizes granted in 1862, and offered for competition in the present and succeeding years. Amongst the former is Lalande's Astronomical Prize, given to Mr. Clark for the construction of an achromatic lens 18½ inches in diameter, and the discovery by its means of a small star in the neighbourhood of Sirius. The proposed prizes include some of great importance. An extraordinary prize of 6,000 francs is offered in connection with the application of steam to naval purposes; a grand prize of 20,000 francs is to be given, in 1866, for the best method of preserving limbs by the conservation of the periosteum. "It has been proved by numerous physiological facts," says the report, "that the periosteum has the faculty of producing bone, and remarkable instances have been exhibited of very large portions of bone being replaced in the human body by means of the preservation of the periosteum. The time is therefore arrived to call the attention of surgeons to a new and most important study, which is equally interesting to science and important to humanity." The Bordin Prize of 3,000 francs is offered, this year, for a "history, anatomical and physical, of coral and other zoophytes of the same family," especial attention being drawn to the natural riches and commercial importance of Algeria in respect to these products. According to the report, the coral-fishery is carried on actively only in the French portion of the Mediterranean, which may be true; but certainly it is hardly correct to say, as the same document does, that "the production of coral is limited to this sea." The grand Bréant Prize of 100,000 francs is offered, this year, for the cure of Asiatic cholera; the successful candidate must produce a medicine which will cure the disease in the great majority of cases; he must indicate in an unquestionable manner the causes of this so-called epidemic with a view to their removal; and, lastly, he must discover a preventive as decided as is vaccination against the small-pox. Failing this, 4,000 francs will be given to the discoverer of the actual existence in the atmosphere of matters which act a part in the production or propagation of epidemic diseases; or, for a radical cure for cutaneous eruptions, and an exposition of the causes which give rise to them. The Barbier Prize of 2,000 francs is offered, this year, for the best work on chemistry or medical botany. Several, if not all, of the above rewards are open to general competition, and the exact conditions in each instance may be obtained by application to the secretary of the Academy.

PARIS, *March*, 1863. Y.

SCIENCE SCHOOLS AND CLASSES.

ON SCIENCE SCHOOLS: THEIR FORMATION AND WORKING.

BY H. P. MEADEN, F.C.S., SCIENCE TEACHER.

SINCE the issue by the Department of Science and Art of the Minute, 2nd July, 1859, by which aid is afforded to the industrial classes in procuring instruction in science, the number of certificated teachers of science, of their schools, and of their pupils has very largely increased.

After the examination, November, 1859, the number of *certificated teachers* was 59; after that, in 1861, it was 158; and at the present time the number will exceed 200. Of *science schools* there were 4 in 1859; 9 in 1860; about 38 in 1861; while the number at present is more than 80. Of *pupils* there were 438 under instruction in 1859; 500 in 1860; 1,130 in 1861, and nearly 2,000 in 1862.

At the annual examinations there were 600 pupils "passed" in May, 1861, and about 1,350 in 1862. These numbers represent about three-fourths of the competing candidates. Much of the success attending the development of the scheme is doubtless owing to the following liberal arrangements:—(*a*), that the office of science teacher is open to all successful aspirants; (*b*), that the classes are under *local* management, and with little interference as respects details from the central authority; and (*c*), that payments are made to teachers on *results.*

Science Teachers.—Many teachers, certificated in science, are employed in National and other day schools, under the Education Department. Those with pupil teachers under them are precluded from taking advantage of the Science Minute, and have, therefore, done little in actual *science teaching.* The classes which have been established are mainly taught by persons entirely or partially engaged in instruction in mechanics' institutions, trade schools, navigation and mining schools, &c., or by such persons as analytical chemists and draughtsmen. They are thus suitable for the office, being "apt to teach," but not dependent on science only for their livelihood, and a fair share of success has been achieved by them. In reference to the abilities of those seeking the office of science teacher, it may be noted that the number who failed to gain certificates in 1860 formed but one-fourth of the competitors; in 1861 only one-eighth; and last year (1862) the proportion was again about one-fourth. Most of the teachers hold certificates in several subjects, and in many cases they have undergone a subsequent examination, in order to improve the *grade* of their certificates; thus "showing," as Captain Donnelly, the Science Inspector, says in his Report for 1861, "the great advantage of having the system of payments in aid, though dependent on results, so adjusted as to allow the personal qualification of the teacher to count for something, thereby encouraging him to go on improving himself." This remark will probably not apply quite so strongly under the Revised Science Code as heretofore. As might be expected, there is great disparity in the number of teachers in the different subjects. About three-fourths are certificated in chemistry; one-third in experimental physics; while in drawing, geology, &c., and the branches of natural history, the proportion is much smaller. Many of the masters, however, conduct classes in more than one subject.

Pupils in Science Classes.—Although the Science Examinations and Queen's Prizes are open to middle-class candidates under certain conditions, as well as to the industrial orders, the latter greatly predominate in number from the nature of the scheme—state payments being made to teachers for the instruction of *artizans only*. In course of time, middle-class schools will no doubt provide for scientific education to a greater extent than exists at present.

Guided by the returns of the last May examination, the following table shows approximately the social standing and relative number per cent. of the "passed" students, numbering about 1,330:—

		Themselves.	Their Children.	Total.
Proportion of	schoolmasters and other teachers	8·27	0·75	9·02
„ „	Pupil teachers	3·46	—	3·46
„ „	Clerks, of various grades, bookkeepers, &c.	17·21	6·60	23·81
„ „	Chemists, druggists, and apprentices	5·79	0·67	6·46
„ „	Handicraftsmen	14·36	9·32	23·68
„ „	Mill-hands, as weavers, &c.	3·30	0·90	4·20
„ „	Shop-keepers	2·33	6·31	8·64
„ „	Mine-agents, miners	0·90	0·37	1·27
„ „	Superior workmen, foremen, &c.	9·55	7·36	16·91
„ „	Middle-class persons	0·45	2·10	2·55
		65·62	34·38	100·00

The most striking features in this table are, that the proportion of teachers is larger than might have been expected; as in most examinations, clerks figure most numerously—the highest, in fact—though they are nearly equalled by the handicraftsmen. The higher class of workmen and superintendents of works are well represented, while the number of persons connected with mining is very small compared with the number examined in geology, mineralogy, and mining. The workers in mills are almost confined to Lancashire and Yorkshire. Middle-class pupils form but one-fortieth of the whole.

It appears that 66 per cent., or nearly two-thirds of the whole, are earning their own living, the remainder being at school or at home. The average age of the pupils is about twenty-one; in some subjects the range is higher, and in others lower. The greatest number of juveniles is found in the chemistry and animal physiology classes; these subjects being taught in some day-schools, where there are large classes, and chemistry being the most popular subject with boys.

The fair sex appeared to have entered into all the subjects (except drawing and physics), but more especially those of animal physiology, geology, and mineralogy. In the latter subjects, indeed, they decidedly take the lead, and occupy a fair place at all times. They seem to be almost confined to the classes in Ireland, Liverpool, and Stroud. Now that several ladies have taken science certificates, and others will probably follow, we may expect to hear of classes for females only, being established. The beneficial influence which such teaching may exert, even upon future generations, is inestimable.

The Science Classes are, in the majority of cases, held in public institutions and schools which possess the advantage of being central and well-known resorts. A responsible committee already exists in them, suitable rooms can be obtained, the work of science teaching can be at once commenced ; the class being formed and recruited from the members of the institution or school, and thus becomes a part of the educational machinery of the place. The charges made for instruction vary in different places, according to circumstances, usually ranging from two to ten shillings per annum ; and it is questionable whether more would be paid at present by the working classes, except in special cases. The time per week devoted to one subject seldom exceeds one and a half or two hours. The subjects which appear to be most studied by those requiring a knowledge of them in their daily employment, are, Drawing, Chemistry, and Mechanical Physics : the remaining subjects (with the exception of Mining) being more suitable to all classes of persons.

As in most new undertakings, considerable obstacles and disappointments are experienced in conducting science schools with satisfaction. The necessity and advantage of obtaining science instruction have still to be made evident to many masters and workmen; so that the demand is not yet great, and in this respect we are behind some of our neighbours on the continent.

At the opening of a Science Class a fair number of students generally enrol themselves, and promise to do well. But some have miscalculated their taste and perseverance ; others are irregular in their attendance, and thus lose the connective parts of the subject ; the time or the place is not suitable to others, *and it is only the real hard working students who persevere regularly and steadily through the entire year's course of lectures, and attend the Government examinations.*

These remarks will not, however, apply with equal force to *Day Schools* where science is taught. A considerable drawback to success in these classes, especially when tested by paper examinations only, is the defective English education of some of the most promising students, and hence much of the teacher's labour is very inadequately represented in the results of the May examinations.

Many of the above difficulties may, however, be overcome by judicious management, and the assistance of those who should encourage efforts for the promotion of science instruction. Masters, in large works connected with the mechanical and chemical arts especially, might lend their countenance and aid in forming classes for their workmen. Farmers in agricultural districts would not find their crops worse or less abundant by obtaining for their sons a knowledge of the principles of agricultural chemistry, or of natural history. Many of the large public and private schools are very tardy in introducing science to their "list of subjects taught."

Much depends also on the teachers. It is for them, by their clear instructions and good illustrations and experiments, to draw out the thinking powers of the students, and enlist their sympathy in the subject. It cannot be expected that all will be equally interested; but the dormant powers may often be thus roused to active inquiry and keen observation. As much as possible the pupils should engage in *practical* work. The conjunctive action of the hands and head often generates an interest not otherwise attainable; and workers are fond of using their hands. They should be encouraged to experiment at home; to collect and arrange specimens, as in the formation of a local museum. Much interest is excited when the pupils will associate out of class hours for mutual help; in the discussion of points in their studies; for excursions in search of natural history and geological specimens; and for visits to museums and other places of interest. They would thus be preparing themselves to become useful members of any scientific society in the locality; friendships would be cemented; their subjects would grow upon them, and become a part of their existence, and a source of never-failing gratification. The perusal of scientific magazines by the advanced students will put them in communion with the superior labourers in the same field with themselves, and lead some, at least, to assist in unfolding the "unknown" in nature.*

As an encouragement to deserving pupils, where the classes are large, one or two of the most promising students might be selected to act as *science pupil teachers* upon a plan similar to those in art and elementary schools. Their duties should be to *repeat* the lesson to young and backward students, or those joining the class at other times than the commencement of the course. If recognized by the Department of Science and Art, a gratuity or other inducement might be afforded to such pupil teachers. In preparing for the yearly examinations, and, indeed, at all times, it is well to accustom pupils to commit their knowledge to paper; and great pains will be required on the part of the teacher in guiding them to state what they know in a short, clear, and full manner, with due attention to the correct use of scientific language. In the May examinations, the examiners have, so far, very wisely, required sound teaching in the first principles of their subjects: this course should be strictly persevered in, if a good superstructure is to be raised; while questions of greater difficulty may, very properly, be set for the more advanced pupils. Success in these examinations will encourage the students to persevere in their studies; and it is not too much to expect that some of those who are fortunate enough to secure the Scholarships and Free Admissions to the Government School of Mines, after steadily persevering in the curriculum of studies at that institution, may become useful labourers in the cause of science, and, it may be, celebrated for their high attainments and untiring zeal in promoting by their labours the comfort and happiness of their fellow-men.

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* The students of the Liverpool School of Science have established a "Students' Association," of which the objects are, to circulate scientific books and periodicals, and at suitable seasons to organize excursions with the teachers. About forty students joined the Association at its commencement, and paid an annual subscription of 2*s*. 6*d*. each, to which several added a donation. We understand that it is working well, and that the best scientific works are circulated amongst the members. It is under the management of a committee of students elected by the members. Perhaps this example may be deemed worthy of imitation elsewhere. *Ed.*

THE GLASGOW SCIENCE CLASSES.

In our last number we had the pleasure to record the successes and honours of many enterprising and diligent *students* obtained at the annual examinations of the Science and Art Department; and now it affords us gratification to enumerate some cases in which *teachers* were enabled to earn honours and secure certificates of competency. One instance is peculiarly gratifying, and deserves especial notice. It appears that, notwithstanding the great obstacles which militate against the attendance of young ladies at the South Kensington Teachers' Examination—difficulties to which we have frequently referred in these pages, and which we think could be easily obviated by a little judicious management—a young lady in Glasgow (Miss Macomish), lately a student in the Free Normal Training College, and at Mr. Mayer's Science Classes, had the courage to go up to London (for the first time), without any companion to protect her, and there attended the Teachers' Examination last November. She obtained a first-class certificate in Animal Physiology, and will no doubt establish a class for ladies in that subject.

We cannot speak too highly of this young lady's spirit, nor too warmly recommend her example to others of her sex; and we once more direct the attention of those who desire to see this movement prosper to the removal of the difficulties which now deter female teachers from visiting London for the purpose of taking out their certificates on science.* From the same city (Glasgow) two gentlemen attended the examination—Mr. John Robertson, who took out certificates in Physics and Inorganic Chemistry; and Mr. Mayer, the teacher (and we believe founder) of the Science Classes, who obtained a certificate of high rank in Metallurgy and one in Systematic Botany.

BELFAST SCIENCE CLASS.

No doubt our readers who are interested in the subject will remember how highly we praised Mr. Ralph Tate, in our number of last October, drawing attention to the fact that he passed 82 students in one branch of science only; of whom 37 carried off prizes of various grades.

We are glad to find that in his case the proverb does not hold good, that

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* See p. 417.

"a man is never a prophet in his own country," for on the 28th of October, at the distribution of prizes, he and his students reaped their several rewards; and we feel sure that the reception he met with from his townsmen will induce Mr. Tate to renew his efforts in the excellent cause in which he is embarked. "There was a large and fashionable attendance on the occasion," and all that art and nature could effect in the way of decoration was done to render the meeting attractive.

The leading people of Belfast attended; and we are very glad to see amongst those who were present the name of Wyville Thomson, Esq., a Professor of Queen's College, Belfast, and one of the editors of the *Natural History Review*. We select the name of this gentleman, who is personally unknown to us, because we think that much of the success of the movement depends upon the countenance and encouragement which it receives from men who hold his position in the scientific world, and who support the movement for its own sake, and for the promulgation of scientific knowledge. Professor Thomson is one of the committee of the Belfast classes.

At the prize distribution Mr. Herdman, the secretary, stated that Mr. Tate has "certificates in six out of seven subjects, in which the Department grants them," and that "the Department considered him the best teacher they have."

Perhaps the most interesting portion of the ceremony was, however, the distribution of prizes; for we believe we never read so large an amount of good common sense compressed into a small space, as that uttered by Mr. R. Davidson, the prize distributor. Without pretending to possess scientific attainments himself, this gentleman, who appears to be advanced in years, and to have learnt to appreciate the value of science, expressed fully the views of the laity concerning the rational pursuit of this branch of knowledge; and the "puerile objections" raised by "weak and narrow minds" to its prosecution on theological grounds.

We really believe that this crusade against the enemies of science (which is becoming so general that we can hardly take up a report of any scientific meeting without finding in it the onslaught of some belted knight) will soon become *fashionable*, and we may hope that then many hearts will be turned, and science schools will be in great request, and become "paying concerns." What a prospect for science teachers! We trust they will keep an eye upon all individual changes of sentiment in this respect and *charge accordingly*.

Mr. Davidson mentioned that eight young ladies have received rewards for merit, and we believe they belonged chiefly to the middle classes. We shall be glad to record the names and achievements of those who take out teachers' certificates, and establish "Science Classes for *Female* Students."

Postscript.—On page 81 ("Popular Science Review" No. 5) we omitted to mention amongst the "most successful schools and classes," those at Glasgow, Salford, and Haslingden. We hope the conductors of these classes will pardon the inadvertent omissions, and as we have already stated, we shall be very glad to give publicity to any communications which are likely to benefit classes about to be, or already established.

FURTHER CHANGES IN THE SCIENCE CODE.

Since the preceding article went to press, the following changes have been made in the Science code.

1. In addition to the teachers' examinations, held annually at South Kensington, London, there will be a simultaneous one in Edinburgh and Dublin, "if five candidates register themselves in Ireland or Scotland."

We have great pleasure in publishing this alteration in the code, as being an important step towards facilitating the admission of ladies amongst science teachers.)

2. In 1864, books will no longer be given to second and third class prizemen, but "cards of merit, recording the result of the examination," will be substituted.
3. Only one (instead of two) silver medals, and two (instead of three) bronze medals, will be granted to successful students in each subject.

(*This change will inflict serious injury upon the whole movement, the books being one of the chief inducements to young persons to become students: and the chance of gaining a medal is already sufficiently small in subjects in which there are many competitors.*)

4. The travelling expenses of candidates for teachers' certificates will in future only be paid to those who are *bonâ fide* engaged in tuition or preparing for it.

GEOMETRY AND CRYSTALLOGRAPHY.

On the Divisions of the Cube, by Mr. Charles M. Willich.—Mr. Charles M. Willich, Secretary to the University Life Assurance Society, has, for a considerable period, been engaged in researches in pure and applied geometry, on the divisions of the cube, and the solids which result from these subdivisions. As early as October, 1860, he had brought before the notice of the French Academy of Science a memoir in which he had arrived at extremely curious results, which we propose to recapitulate.

The solid triedral angle of the cell of the bee is formed of three plane angles, having each an angle of 109° 28′ 16″. The ordinary dodecahedron with rhombic faces may be deduced from the cube in many different ways. If, from the centre of a cube, planes of divisions be made passing through the edges of the six squares which form its surface, there will result six pyramids with square bases. If these six pyramids have their square bases placed on the six faces of another cube of similar dimensions, the ordinary rhombic dodecahedron is formed, which has, consequently, the volume of two cubes. Two of the pyramids derived from the cube being joined base to base, form an octahedron, the volume of which is one-third of that of the cube, and, consequently, one-sixth of the volume of the above described dodecahedron. If one of these pyramids be cut into two equal parts, and the two halves be brought together by turning them over, a solid is formed, three of which form a rhombohedron. Four such rhombohedrons form the dodecahedron with rhombic faces, and seven of these rhombohedrons afford a prolonged dodecahedron, which is that of the cell of the bee.

Mr. Willich has subsequently discovered some new subdivisions of the cube, one of which is especially interesting. It is produced by carrying through the alternate solid angles of the cube six planes meeting at its centre; these planes divide the cube into four equal and similar parts. The solids thus produced have precisely the same solid angle as that of the roof of the bee's cell. Consequently if these solids be grouped back to back, one-half of a rhomboidal dodecahedron is produced. Each of these solids, equal to a fourth part of the cube, is formed of two triedral pyramids united together; the angle of one is 109° 28′ 16″, that of the other 90°. If each of these four double pyramids be divided into two other triangular pyramids, it will be found that the four pyramids having an angle of 109° 28′ 16″, form the regular tetrahedron, the solid content of which is, consequently, one-third that of the cube from which it is derived; that the four other pyramids, the angle of which is 90°, turned over and placed back to back, constitute a pyramid with four equilateral faces, equal to half the regular octahedron, and equal in consequence to two-thirds of the primary cube. Thus, the same analogy will be found to subsist between these three bodies as there is between the cylinder, the sphere, and the cone; in the sense that the cube, the quadrangular pyramid derived from it, and the regular tetrahedron, are precisely in the ratio of the three numbers 3, 2, 1.

By another kind of section which consists in carrying the intersecting planes through the diagonals of the six faces of the cube, four solids are cut off, leaving in the centre a regular tetrahedron. These four solids are similar to four of the solids previously obtained, and form similarly a quadrangular pyramid which is half a regular octahedron.

The solids resulting from the section of the cube have yielded to Mr. Willich, amongst many others, two polyhedrons very deserving of attention—one, with eight summits, results from the reunion of two tetrahedrons, and its volume compared with that of the cube from which it is derived is $2\frac{2}{3}$. The second has twelve summits, and its volume is four cubes. The former polyhedron with eight summits is reduced by the simple removal of its summits to the regular octahedron having equilateral triangles for the faces of the octahedron, the volume of which is one and a third times the volume of the cube; it is thus the volume of the whole of the eight tetrahedrons which have been removed.

The second polyhedron is formed, as already stated, of four cubes, and is reduced to the rhomboidal dodecahedron by the removal of its summits. These twelve summits removed, have the volume of two cubes, as has likewise the remaining dodecahedron. The sum of Mr. Willich's researches renders the conclusion highly probable that the symmetrical polyhedrons which result from the union of the sections of the cube, or of the elementary solids of which it is composed, comprehend not only all the polyhedrons of geometry, but nearly all regular crystals. (*Les Mondes*, No [illegible]5-57.)

H. W. B.

SCIENTIFIC SUMMARY.

QUARTERLY RETROSPECT.

ASTRONOMY.

Difference of Longitude between Greenwich and Valentia.—The Astronomer Royal, under whose superintendence this inquiry was determined in 1845, by the transmission of chronometers, has recently verified it by signalling with the electric telegraph, when almost exactly the same result was arrived at. It is strange that there should have been so great a difference in the result found by these two processes in the case of Cambridge and Greenwich (a comparatively short distance), namely, by chronometers in 1828 and by telegraph in 1853; but probably greater precautions had been taken in the carriage of the chronometers in the Valentia expedition. It is stated that the current took one-tenth of a second to traverse the 800 miles of wire.

This is, however, only a preparatory step, before endeavouring to determine the length of the arc between the most western point of Europe (Valentia, in Ireland), and the town of Orsk, in the east of Russia. By combining the numerous old and some new triangulations, which it will be necessary to take, it is intended to measure this in *yards*. The distance between the two stations is *seventy degrees*, so it may be imagined how many units of that popular cloth-measure shall be swallowed by this mensuration. The differences of time at the east and west points will be obtained, when available, by the telegraph.

The Elchies Refractor.—In our last summary we gave Professor Smyth's experiences with this instrument (11-inch aperture), showing the existence of many small stars whose places had not been previously recorded. Mr. Dawes has, however, been able to detect many, if not all, of those with a telescope of 8¼ inches aperture. He points out that "the most valuable property in a telescope is undoubtedly a fine sharp definition;" and concludes that an object-glass of 11 inches will show a star whose magnitude is about 12½ of Struve's scale, or 18½ of Sir J. Herschell's. Mr. Knott has also been able to detect all the stars of 222 Piazzi I., the star B., missed by Professor Smyth, being readily seen.

Variable Stars.—A proposal has been made for establishing an association for the systematic observation of variable stars. A similar association was formed some sixty years since for the detection of the smaller planets, each observer taking a particular district of the ecliptic, and some good results followed the attempt. These were, however, surpassed by the individual exertions of later years—each planet-seeker working promiscuously. Now, however, that the list has attained such dimensions, the question of variable stars is a favourable field for division of labour.

Mr. Knott finds that the variable star R. Vulpeculæ may reasonably be classed under the head of regular variables, although he at first suspected some irregularities in its change of brightness. He observed it at its brightest point, 1861, Dec. 30, and 1862, Oct. 4, being only 3½ and 4 days later than the times predicted by Dr. Winnecke, and giving a period of 138¾ days.

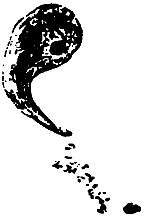
The variable star U. Geminorum, which Mr. Pogson describes to be subject to such remarkable changes, *viz.*, from the 9th to the 13th May, in intervals from nine to fifteen seconds, still continues its eccentric course. Mr. Baxendell observed it on Dec. 26, 1862, of the 10½ mag., when it should have been below the 14th; on the 29th and 30th it was invisible. Mr. Knott assumes it from observation to have been invisible, or below 12½ mag., on Dec. 20.

Stellar Spectra.— This subject appears to be in rather a confused state at present, for Professor Donati finds different lines from Frauenhofer in nearly all the stars; and a careful American experimentalist again differs from Donati. The latter astronomer, however, made use of the micrometer in determining their places, and he thinks that if only eye-measures are employed one may be easily deceived, owing to the extreme faintness of the colour, in which the reddish tinge is the only one visible. Frauenhofer finds a fine line in the green, Donati in the blue. The former finds, between the yellow and red, a line in Pollux, Capella, Alpha (Orionis), and Procyon, which the latter has never seen. Frauenhofer found Procyon very difficult, whilst Donati found it easy. As the Astronomer Royal has instituted a series of experiments we may expect these points to be speedily determined.

Photographs of the Moon.—Mr. De la Rue has succeeded in obtaining an enlarged picture of the moon, equal in size to the great map of Beer and Maedler, *viz.*, 38 inches in diameter; the original negative being only one inch in diameter. There must be a combination of very favourable circumstances in order to obtain a good picture—"atmosphere, collodion, instrument, driving clock, all must be perfect." Mr. De la Rue has taken four hundred negatives during the last five years, yet of those only about twenty are capable of producing a perfectly sharp photographic record. The beautiful specimens which we have seen at the Exhibition prove that this vast amount of labour has been well rewarded.

The fine specimens of lunar photography, accompanying Dr. Vengeur d'Orsan's book on the moon, were much admired when they first came out; but circumstances have since occurred which have in a great degree disturbed and affected this opinion of their merits, and doubts are expressed, not as to their accuracy, but as to their originality. If they be original, it will of course be a simple matter to produce others not bearing such a resemblance to those of Mr. De La Rue, which are known to be *bonâ fide* pictures.

Spots on the Sun.—During the past quarter the sun has been very rich in spots, and many groups along the equator were seen at the beginning of March. A spot, seen on March 1, to the western side of the sun, appeared of a spiral form; but two days later it did not seem to have shifted its direction, although it was considerably broken up and a quantity of luminous matter was mixed up with the penumbra and nucleus. Mr. Howlett questions the existence of the notch on the sun, photographed by Mr. Titterton (of Ely) on the morning of August 4, which was doubtless seen by many at the Exhibition. He observed the sun three times on that occasion, and could still distinctly see its margin. It would appear that the eye on such occasions is more sensible than the collodion, Mr. Howlett being able throughout the day to perceive a brilliant streak of photosphere between the spot and sun's limb, whilst the photograph makes the spot and sky run together, thus producing the notch. A similar occurrence took place on October 1, the photograph showing a notch, and the telescope none.



At the December meeting of the Astronomical Society, the Astronomer Royal exhibited a picture of the fringes of light seen on a wall before the disappearance of the sun in the total eclipse of 1861, December 31, taken by Captain Poulain at Goree. The wall was white, and five bands were observed, each four inches broad, three white and two dusky dark. The length of the fringes was in the same plane as the tangent to the discs of the sun and moon at the place of its last disappearance. These flitting shadows have been noticed previously, but the explanation is still obscure. They were particularly seen in the eclipses of 1842.

Saturn.—From observations of Saturn made about the time of the disappearance of the ring in May last, M. Struve thinks that there are certain luminous appendages which are not the same as the ansæ of the ring. They extended to a distance equal to one-half or one-third the diameter of the ring, differing much from the ordinary colour of the ring, being of a livid colour, brown and blue; their size increasing at the margins of the planet, giving them the form of sharp wedges. From a communication made to the Astronomical Society in December, these curious appendages were likewise observed by Mr. Wray at the disappearance of the ring in 1861, December 26, and 1862, January 5. It gave him the impression that it was the dusky ring, very much thicker than the bright rings, and seen edgewise, projected on the sky.

Mars.—Mr. Joynson, of Liverpool, submitted a series of thirty-six drawings of Mars to the Astronomical Society, made between September 25, and November 10, 1862. He concludes from these that the band is continuous around the planet, except where a pale yellow stripe crossed it; that the snow at the south pole was not exactly at the axis of rotation and that the time of rotation was 24h. 37m. 49s. Mr. Grove thinks that changes take place in the distribution of the lights and shadows of Mars by clouds condensed over large aqueous districts.

Halley's Comet.—M. Angstrom, by comparing all the known appearances of Halley's comet, has proved the existence of two new periodic inequalities in the time of its revolution, by the combined action of which the time of the appearance of the comet may be accelerated or retarded from one revolution to another by about a year and a half.

Occultations and Eclipses at Sea.—Mr. David Smith denies the impracticability of observing such phenomena at sea, and proves it by his own example, he having taken such observations with a common ship's glass. He states that unless the ship is very uneasy, stars up to the 3rd magnitude are easily observed.

Parallax of Stars.—The parallax of 61 Cygni, found by Bessel to be 0″.366, was afterwards found by Struve to be 0″.51. M. Auwers brings it nearer still, making it 0″.57.

Planets and Comets.—The bright comet of August and September, 1862, is found to have an elliptical orbit with a period of 142 years. The first of the two comets detected by M. Bruhns on November 28, was discovered three days earlier by Professor Respighi at Bologna. No new planets have been discovered since the Danish Goddess Freia, detected at Copenhagen, November 14, 1862, by D'Arrest. Some fine spots are now visible on Jupiter.

BOTANY.

Cinchona Trees.—The Indian Government has been forming plantations of cinchona trees on a large scale on the Neilgherry Hills. The total number of plants at present is 72,568; of these, 13,700 are placed permanently out of doors, 18,076 are in the plantation nurseries, and the remainder are small, and kept under glass. Extensive clearings, amounting to 700 acres, are being made for further planting of this valuable tree.

Substitutes for Cinchona.—MM. Joret and Homolle have presented to the Society of Pharmacy at Paris, a new product obtained from common parsley seeds (*Apium graveolens*), to which they have given the name of Apiol, and for which they claim the medicinal properties of Peruvian bark. Another plant, much used in India for the same purposes as cinchona, has been lately introduced into France by the Société d'Acclimatization, *viz.*, the seeds of Cæsalpinia Bonducella, or the Natha plant, which, according to Mr. Hayes, their correspondent, is a small creeper, producing a nut, the kernel of which is extremely bitter, and possesses, in an eminent degree, the qualities of Peruvian bark. It is proposed to cultivate the plant in Algeria and the south of France.

Sun spurge (*Euphorbia helioscopia*).—The "Annales d'Hygiène Publique" states that the goats of the island of Malta, after feeding upon this plant, called by the inhabitants Tenhuta, have produced noxious milk, which caused symptoms of poisoning in the case of several officers of English vessels in the harbour.

Blue-gum tree (*Eucalyptus globulus*).—This magnificent tree, a [illegible]alia, is now in course of cultivation at Algiers, and in the

Jardin des Plantes, at Paris, where a few good subjects are now being reared. This tree only bears blossoms at the very top, so that to get at its flowers, its discoverer, M. Labillardière (in 1792), was obliged to have one cut down. The circumference of the base was about 90 feet, and 65 feet at the height of five feet from the ground; its total altitude was 300 feet, and the section presented upwards of 800 concentric rings. The wood is extremely hard, and used as timber for ship-building purposes, dykes and piers at Hobart Town, and the leaves emit a delightful perfume. In 1860, Dr. Müller sent over some seeds of this tree to the French Minister of Marine, who immediately dispatched them to M. Hardy, the director of the nursery at Algiers; and there is every reason to believe that this remarkable and beautiful tree will be acclimatized in France, or, at least, in Algeria.

The Mistletoe.—A correspondent, Mr. Birschel, of Liverpool, referring to the paper on this subject by Mrs. Lankester, in the last number of the "Popular Science Review," states that having been brought up in a country abounding in forests of black fir and pine (the Vosges mountains), he thinks the statement that the "instances of the mistletoe attacking the coniferæ are very rare" should be modified. The parasite abounds in these forests, and people make a livelihood by gathering it at certain seasons, as food for cattle; but while it is to be frequently found on the black fir, he states that he has never seen it upon the pine. It is more common upon old and stately trees than upon young or dwarfish individuals.

Raphides in British Plants.—Mr. Gulliver, F.R.S., after an examination of many hundred British Phanerogamic plants, found raphides in the following, while in a much larger number of others they were not detected. In many other orders not here noticed they were looked for, but not found. *Caryophyllaceæ;* in *Silene armeria. Onagraceæ;* raphides are characteristic of this order, and serve to distinguish it from the allied orders, Lythraceæ and Halorageæ. *Rubiaceæ;* common in the genera Sherardia, Asperula, and Galium. *Compositæ;* raphides less common here than other forms of crystals but they are found in the subdivisions, Corymbiferæ, Cynarocephalæ, and Cichoraceæ. *Dioscoreaceæ;* found in black bryony (*Tamus*). *Orchidaceæ;* abundant in all the plants examined. *Iridaceæ;* in *Iris pseudacorus. Liliaceæ; Endymion nutans,* abundant in all parts of the plant, but not found in, bear garlick (*Allium ursinum*). *Typhaceæ;* in sparganium, but not in Typha. *Araceæ;* abundant in *Arum maculatum. Lemnaceæ;* abundant in *Lemna trisulca;* scanty in *Lemna polyrhiza* and *L. gibba.* In conclusion, Mr. Gulliver remarks that the abundance of raphides of phosphate of lime in *Lemna minor* (or common duck-weed), associated with quantities of starch granules, point out that despised and abject weed as a most valuable one to be used as a highly fertilizing manure.

Fruiting of the Oak.—M. Alphonse de Candolle calls attention to a new character in the oak; viz., that certain oaks ripen their fruit at the end of the first year, while others do so in the course of the following year. For half a century this character has been neglected; and it has just been found that under the name of *Quercus suber* (cork oak) two species have been confounded,—one with annual, and the other with biennial fruit. Although, however, this character, when once determined, is perfectly fixed to each species, it is not linked with any other, and consequently two species very analogous may present fruits, in the one, annual, and in the other, biennial.

Colouring Matter of Flowers.—"The Natural History Review" gives the observations of M. Hildebrand upon this subject, the conclusions of which are, that the colours of flowers are in constant connection with the contents of the cells, and never with the cell-wall. Blue, violet, or rose-colour, and (if there be no yellow) deep red, are due to a cell-fluid of corresponding colour; while yellow, orange, and green, are usually associated with solid granular or vesicular substances in the cells. Brown or grey, and, in many cases, bright red and orange, apparently uniform to the naked eye, are found to be compounded of other colours; as yellow, green, or orange, with violet or green and red; bright red and orange in like manner of blue-red with yellow or orange. Black, except in the bean, is due to a very deeply coloured cell-fluid. All the cells of an organ are very rarely uniformly coloured, and the colour usually resides in one or in a few of the outer layers of cells, while the coloured cells are but exceptionally covered by a layer of uncoloured ones. Combinations of colour are occasioned by diversely coloured matters in the same or in adjacent cells.

New Botanical Journal.—In order to fill up an acknowledged want, a scientific Botanical Magazine has just been issued by Mr. Hardwicke. It is called the "Journal of Botany, British and Foreign," and is under the able editorship of Dr. Seeman. The second number is published.

CHEMISTRY.

DR. LETHEBY'S annual report on the sanitary condition of the City of London was issued a short time ago, from which it appears that although during rainy weather there is no upward flow of sea water, in the summer time a great quantity finds its way up the river, and necessarily it will bring with it the sewage which the Board of Works have been taking so much trouble to remove out of harm's way. It will probably be brought back beyond the Houses of Parliament, and will be all the more unpleasant for being mixed with sea water; to add to the difficulty, there has not as yet been proposed any satisfactory remedy for the evil, and in fact the question what to do with the sewage is in very much the same state as when it was first brought before the attention of the public; everyone agreeing that something must be done to remedy the evil, but no one being able to satisfactorily answer the question—what is to be done? The Chinese manage these matters much better than we do in England, and instead of throwing that which is in reality an immense fortune into the sea, carefully preserve it. The Chinese greengrocer every morning when he leaves the vegetables carries away with him this objectionable matter, which is then applied to the fertilization of the soil; this no doubt accounts for its fruitfulness in that country. Of course the difficulties of employing a process of this nature in a town like London are not to be disputed, but the real question is,—will it pay to overcome them? And this question may possibly before long be answered in the affirmative.

Dr. F. Crace Calvert has been making some experiments on the action of sulphuric acid on lead, from which it appears that pure lead is much more rapidly attacked by the acid than that containing small quantities of other metals, and in fact so small a quantity as 0·4 per cent. of tin contained in lead diminishes the action of the acid about one-third; a point of some importance to sulphuric acid manufacturers.

Drs. Lawes and Gilbert have for upwards of twenty years been making experiments on the assimilation of nitrogen by plants; their last results have reference to the question whether plants possess the power of assimilating free nitrogen. The method of procedure was to enclose the plant in a glass vessel and to supply it with a current of air which had been washed with sulphuric acid and with carbonate of soda; the soil employed had been previously ignited and allowed to cool over sulphuric acid; carbonic acid was occasionally supplied with the air that passed through the apparatus. The seeds that were allowed to germinate under these circumstances showed a singular power of prolonging their vitality; one part feeding on the nitrogenous matter set free by the decay of another part, but in no instance was there found to be an increase in the amount of combined nitrogen beyond that originally contained in the seed.

Two deaths have lately occurred from the inhalation of the vapour of nitric acid. A bottle containing the acid having been broken and the contents spilt on the floor, the fumes acted on the lungs of the two persons present to such an extent that, although they felt no immediate ill effects, they both died, one within about ten hours and the other within two days after the occurrence. This serious accident should serve as a caution to chemists, and others who are liable to be exposed to acid fumes.

M. Crova has succeeded in producing artificially the compound of acetylene and copper, which is found in the interior of copper tubes which have been employed for the conveyance of coal gas, and which possesses the property of detonating by a blow, or by a slight elevation of temperature. The mode of proceeding was to expose finely divided copper to the action of a mixture of equal volumes of air and acetylene; the absorption of gas appears to be greater if a little ammonia were present.

The very rare metal rubidium has been found to exist in a situation where few would perhaps anticipate its presence, namely, in ordinary beetroot; the raw beetroot salt has been found to contain from 0·13 to 0·21 per cent. of chloride of rubidium.

The equivalents of the two metals nickel and cobalt have lately been determined with great accuracy by Dr. W. J. Russel. He adopted the precaution of igniting the oxide of cobalt, employed for the determination of the equivalent, in a blowpipe flame, and of cooling it out of contact with the air, by which a definite protoxide was obtained; the oxide was then reduced by hydrogen. The equivalent of cobalt determined in this manner proved to be 29·37, and that of nickel, determined by a perfectly similar process, was found to be 29·369; the coincidence between the two equivalents being very striking.

M. Dietzenbacher has lately discovered some singular properties of sulphur. He found that when acted upon by small quantities of iodine, bromine, or chlorine, it became soft and malleable at the ordinary temperature, and retained this property for some time. This modification of sulphur, which was originally discovered by M. St. Clair-Deville, is insoluble in bisulphide of carbon. It is considered that this transformation may throw some light on the details of the manufacture of india-rubber vulcanized by sulphur and chloride of sulphur.

M. Ern. Guinet has been investigating the phenomena of transport through porous bodies, and has found that Mr. Graham's dialyser could be replaced by a porous vessel of pipeclay, similar to those employed for batteries. With such vessels he states that he has repeated many of Mr. Graham's experiments, and has been able to perform others which appeared impossible, with vegetable parchment. He found, for instance, that a mixture of solutions of sugar and gum were easily separated by this means, the sugar passing through the porous clay and the gum being retained. With the same apparatus he succeeded in separating caramel from bichromate of potash; and he has an experiment still going forward on an ammoniacal solution of oxide of copper. This solution could not have been submitted to dialysis with vegetable parchment on account of its action on that material.

The diffusibility of solutions of solids in other liquids was also tried, as, for instance, solutions of iodine, sulphur, and naphthaline in bisulphide of carbon; if a solution of these three substances is submitted to dialysis, the sulphur and naphthaline pass through the dialyser much sooner than the iodine, from which he infers that the smaller the molecules of which a substance is composed, the more readily do they pass through the porous diaphragm, which may be viewed as a kind of sieve. The molecules of colloids may be supposed to be made up of larger groups of atoms than those of crystalloids, and hence would be more easily retained by the diaphragm.

GEOLOGY AND PALÆONTOLOGY.

LONG before the ages of Boulder-clay, and Drift, when the climate of England was much as it is now, and about the time when the Newer Crag was deposited, the Norfolk shores were skirted with dense forests. From Happisburg to Cromer, and much farther, they are to be seen along the level of a deposit, marked by fossil shells, which indicate the sediment of old contemporary lakes and rivers, of which there is now not a trace. After a series of changes, the Drift period supervened, the forests were thrown down, and a dark brown clay, with boulders as big as cottages, was piled sixty feet high, over lake and forest, as the country sank under the sea. And now, after innumerable ages, this same sea has again eaten away part of its last-formed stratum, till the brown clay stands as a bold cliff, and exposes at its base the old land on which the forest grew. Searching among the old tree stumps we may find acorns and beech-nuts, and here, and by dredging on an extension of the bed out to sea, are gathered large bones, commonly black, and often pyriteous. These are the remains of large mammals, which lived on the old land. There is the hippopotamus buried in the mud of the river in which he swam; the elephant among the trees which were his food; and the rhinoceros, and many others, are there too. Such is the Norfolk Forest bed, specially interesting as the earliest deposit known to contain the Mammoth.

This species, the *Elephas primigenius*, is the most abundant of the English fossil elephants: it has, too, the widest range in space, and the longest duration in time. Authentic specimens are found throughout England, France, Germany, and Italy, as far south as Rome. Thence it ranges across the steppes of Russia, through Siberia to Arctic America, and east and south to Texas. With a distribution so wide, believed to be the result of slow migration, it would be natural to expect a long-continued existence in time.

Its teeth are met with in Central Italy, in a volcanic gravel believed to be nearly, if not quite, as old as the Forest bed. The matrix abounds in crystals of *Leucite* and other minerals; so that the species certainly inhabited that district when the extinct Latian volcanoes were active.

Although it is certain that as the Glacial period advanced a few ice-clad hills were all that remained above the sea of England, so that its mammals must have died off and migrated; yet no sooner was the country dry land again, with wood, and river, and lake, than the species became as abundant as ever. In the gravels which were then forming, its remains are plentifully preserved, and it not unfrequently occurs in caves. There is here no variation in its character; nor do any of the specimens found in this, or more recent accumulations, indicate those changes which intervening space and time are generally found to have effected. Immutable he lives on, giving no indication of whence he came. The existing elephant of India is the known form most nearly resembling it, but there is nothing to suggest that he went thither, nor is there any evidence to support the supposition that a species which endured endless migrations, and changes of food and climate, for so long a period, was at last so rapidly metamorphosed into the Indian animal that no trace of the process can be found.

When the species occurs in the gravel, the *Rhinoceros etruscus*, and many of its companions in the old Forest age, have disappeared, and are replaced by *Rhinoceros tichorhinus*, and many new forms. This rhinoceros in its turn dies out, and yet the mammoth shows no signs of being on the wane.

The next most recent beds in which it is met with are the frozen Siberian gravels, whence traders in fossil ivory have collected its tusks for ages. A skeleton, with much of the skin on the head, is preserved at St. Petersburg, and, according to Von Middendorf, many entire carcases have since been discovered.

Then comes a turbary deposit in the Apennine valley of the Chiana, in Tuscany, where most of its old associates are absent, and it is now accompanied by the more modern animals, *Cervus Megaceros*, *Bison priscus*, and *Bos primigenius*, species characterizing bogs and latest accumulations, and which were probably exterminated by man,—the *Bos primigenius* being certainly slain with stone celts by early Britons.

And finally, Sir C. Lyell, long ago, described a locality in Tennessee, where the Mammoth was discovered, together with *Mastodon ohioticus*, and existing shells, in a swamp formed in a cavity of the boulder formation.

These are a few facts in the life-history of this animal. Surviving through two distinct periods, Geoffrey St. Hilaire suggested for it the name of *Dicyclotherium*. Much information on this and other topics has lately been given by Dr. Falconer, in a discursive paper on an American fossil elephant.

Mr. Salter has described many new *Phyllopod crustacea* from the palæozoic rocks; and with a view to show what bearing these have on the doctrine of transmutation of forms, has given a diagram exhibiting side by side the several genera found in palæozoic strata. Earliest in time comes the *Hymenocaris*, found in Lingula flags. This genus is characterized by a carapace in one piece, bent over the body. In the superimposed Cambro-Silurian, the order is represented by *Peltocaris*, a form with the circular shield or carapace in three pieces—that is, two equal valves, with a semicircular piece inserted between them covering the head. Between this and the previous form there is no relationship whatever. Peltocaris is succeeded in the Upper Silurians by *Ceratiocaris*, which is also in three pieces, but the valves differ much in shape, and the relation of the wedge-like rostral piece is different. However, there is that close affinity that would induce a comparative anatomist to predict the discovery of intermediate genera when the rocks shall be better explored. In the Devonian strata the genus is *Dipterocaris*, a form quite unlike the preceding, with a carapace in one piece, and bent, which seems very nearly to reproduce Hymenocaris of the old Cambrian rocks.

In the Lower Carboniferous, occur *Dithyrocaris*, and the nearly allied genus *Argas*. Argas is a form very like Ceratiocaris, with the valves separate, but it appears to want the rostrum; Dithyrocaris appears to have had a rostrum, but in it the valves were soldered together.

Then in the Trias we find the recent genus Apus, which resembles Dipterocaris but not very closely. So there are, on the one hand, Hymenocaris, Dipterocaris, and Apus forming a sort of natural succession, on which Mr. Salter remarks that "Apus is unquestionably the most highly developed, and it is the latest." And on the other hand, Peltocaris, Ceratiocaris, Argas, and Dithyrocaris, forming a sort of harmonic progression, in which the rostrum gets gradually less important, and the carapace more concentrated. We should consequently regard Dithyrocaris as probably the most highly organized of this group. And it is worthy of remark that that genus is more nearly related to Apus than is Peltocaris.

The facts are few, but they appear to indicate a method or plan in the succession of life on the earth.

Geology has lately lost in Mr. Lucas Barrett one of its most accomplished students. From his earliest years there had been a great fondness for natural history specimens, and even at an early age a faculty for original observation was active, for at school he discovered a layer in the chalk rich in univalve shells, and the specimens there gathered served as a nucleus for a mor [illegible] chalk gastropods, long afterwards commenced for the

Palæontographical Society. In 1853 he went to Ebersdorf, where he was chiefly occupied with chemistry and botany; and made collections of minerals and plants from the Hartz.

Returning to England after a year, natural history became his sole study; and shortly afterwards an engagement was obtained in that department of the British Museum. Here he worked chiefly at the Crustacea, arranging the Cirrhipedes. When but eighteen he visited Cambridge, and Professor Sedgwick at once secured his services in classifying the fossils of the Woodwardian Museum. It was at this time he went with Mr. M'Andrew through the Northern seas to North Cape, dredging; and some idea of his knowledge and skill may be formed from the dredging papers printed in "Woodward's Mollusca," and from a communication to the "Annals of Natural History," which was translated into the principal European scientific journals. One important object of this voyage was to discover the effect of the Gulf Stream on Northern forms of life, and the result is admirably given in the dredging papers mentioned. He now became F.G.S.; and next year, 1856, still busy with the Northern problem, went alone to Baffin's Bay and West Greenland to discover an Arctic fauna *unaffected* by the Gulf Stream.

Providentially delayed at Copenhagen, he missed the first trader, which foundered at sea. It was the seal-hunting season when he arrived, and no one, native or European, could be induced to assist him, till the temptation of sugar and coffee procured the help of eight strong Esquimaux women, who, with great courage and skill, rowed him about for two months among the floating ice, in an open boat. During all this time dredging was carried on actively; and not only did he effect his purpose, and discover that lines of distribution of life drawn through the sea would, like the isothermal lines, have to bulge up and be carried far to the north on the European side; but, with a view to determining what relation in that region the life in the sea would bear to that preserved in the deposit it was helping to form, he dredged up the sea bottom. Sketches and observations, too, were made among the Greenland glaciers, and on one of these occasions he nearly lost his life. Returning to Cambridge, the treasures gathered were stored in the Woodwardian Museum, of which he may be said to have almost created and named the natural history portion.

His attention was now given almost exclusively to comparative anatomy and the study of fossil bones. But next year, in 1857, he again accompanies Mr. M'Andrew in a voyage to Vigo Bay. Here he made an extensive collection of Echinoderms, and the Northern forms of mollusca, which, though surrounded by Southern forms, here maintain themselves as an evidence of that general migration southwards of Arctic life which occurred during the glacial ages. And in conjunction with Mr. Woodward a communication was made to the Zoological Society on some *Synapta* and *Cheirodota*.

Back to his duties at Cambridge, he removed thither and arranged a large local collection of chalk fossils, purchased at the death of the Rev. T. Image, and the beautiful lias saurians presented by Mr. T. Hawkins. At the meeting of the British Association in 1858 he read an important paper, connected with the controversy between Professors Owen and

Huxley, on the nature of the atlas and axis in Plesiosaurus; and early in the same year he himself discovered the remarkable condition of the atlas and axis of Pterodactyle; and a little later detected, in the Upper Greensand, the remains of small birds, on which a communication was made to the Cambridge Philosophical Society. About this time he occasionally lectured for the Woodwardian Professor; and the wants of the class turned his attention to field-surveying, which in 1859 bore fruit in the excellent geological map of the Cambridge district.

In the previous October he became an undergraduate of Trinity College, but kept only one term; for in March, when but twenty-two, he was appointed by Sir H. Bulwer to the important office of Director of the Geological Survey of the West Indies. He now married, and within a month left England for Jamaica. Here was a field of usefulness every way worthy of his genius, and right heartily did he set about his new duties.

As was to be expected, the survey progressed rapidly, and he speedily communicated to the Geological Society a paper on some important features in the geology of the island. His duties carried him into wild unvisited parts of the country, and those who have listened to the marvellous story of his adventures in the land of the Maroon ghosts will regret that he wanted the literary faculty (or inclination) to have given us, as he might have done, as remarkable a book of travels as any of modern times.

Among his discoveries was a singular new fossil, named after him, by Mr. Woodward, *Barrettia*, but much against his wish. Dredging again was carried on actively, and among the more important results was the discovery of an Arctic fauna in the deep cold waters of the Mexican Gulf.

In the spring of last year he returned to England, bringing the result of nearly three years' work in geological maps, and a large series of West Indian produce for the Great Exhibition. He remained till October, working incessantly; now at astronomy, now analyzing West Indian minerals, now preparing his first volume on Jamaican geology, and, after attending the British Association, and taking an active part in the meeting, returned to Jamaica full of hope.

Feeling of what little value much of our knowledge is from so little being known of the ways of life of animals on the sea-bottom, he took out with him a diving apparatus in which to watch their habits, and especially to examine the coral-reefs. On the 17th of December, four descents were made in shallow water in Kingston harbour; and the following day he expressed to friends in the House of Assembly, where he was giving evidence before a Committee, the greatest delight at what he had seen. On the 19th, against all advice it is said, he determined to go down in deep water; and, as no white man was there to accompany him, pulled off with six negroes; and, having arranged everything himself, descended outside the Cape, near Port Royal, taking the signal line in his hand. For twenty minutes he gave no signals, and it was then found he had parted from the line. Unable to regain it from some cause, probably the effect of pressure of the water consequent on a rapid descent, he appears, as a desperate expedient, to have closed the escape valve of the air tube, and shortly afterwards his lifeless body rose to the surface. On the following day he was buried in Half-tree Churchyard, Kingston. Thus sadly, at the age of twenty-five, ended as brave a life and as noble a spirit as science has ever fostered.

In a letter to the writer, Professor Sedgwick speaks of having felt for him "sentiments almost of paternal love;" and goes on to say, "Natural science has been deprived of the services of one whose genius, and zeal, and intrepidity gave a promise of a glorious harvest of honour to himself, and, I might say, to his country."

MECHANICAL SCIENCE.

The Repair of the Great Eastern.—It will be remembered that this vessel struck on a sunken rock at the entrance to Long Island Sound in August last, ripping open the outer skin of iron plate for a distance of 85 feet, the fracture measuring in width as much as 4 feet at parts. Owing to her peculiar construction with a double sheathing, the interval between the skins being divided into cells, she was enabled, notwithstanding the accident, to proceed on her voyage and land her passengers and cargo in safety. It is even thought that she might have returned to England without danger. The agents of the Company in New York, however, determined on her repair before risking another voyage, and there being no dock of sufficient size, a novel and ingenious plan was resorted to, for gaining free access to the damaged part. A timber caisson, coffer, or "scow," was constructed, 104 ft. long, 15 ft. wide, and 8 ft. high, of great strength, and fitting, as closely as might be, to the curved side of the vessel. This was sunk over the fracture, and sustained in its place by chains passed round the hull. A water-tight joint between the "scow" and the side of the vessel was constructed by means of an india-rubber hose-pipe, placed in a shallow groove round the edge of the "scow," and when the latter had been firmly fixed in its place, filled with water under pressure by a force-pump. The "scow" was then pumped dry and formed a long water-tight chamber on the outside of the vessel, to which access was gained both for men and materials by two trunks, each 6 feet square, curving upwards along the side of the vessel to a point above the water level. A patch from 4 to 6 feet wide, and 93 feet long, was then riveted over the fracture, and the vessel rendered as strong and seaworthy as before the accident. The vessel is now undergoing repair on the shores at Rock Ferry, near Liverpool; and was for several days high and dry on the beach, so that spectators could walk round and examine every part of the hull.

The Metropolitan Railway.—The opening of this subterranean line marks a successful step towards the relief of the overcrowding of metropolitan thoroughfares. The depth from the surface to the level of the rails varies from 26 to 54 feet at different parts. The tunnel is elliptical, 17 feet high and 28½ feet span, except in the deeper portions, where the height of the tunnel is increased. The gradients do not exceed 1 in

100, the curves are not less than 200 yards radius, and extreme care has been taken in the arrangement of the signals to prevent accidents. Trains are to be run at five-minute intervals, and the resources of the line have already been taxed to the utmost to convey the passengers over the short distance of 3¾ miles at present open. The locomotives are peculiar in having a condenser, and means of preventing the escape of the products of combustion whilst within the tunnels.

Pneumatic Despatch Company.—A short length of tube has been laid by this company, and is in successful operation. It is a revival, on an unobjectionable plan, of the atmospheric system of traction tried in this country and Ireland and ultimately abandoned. Formerly, as the train on the outside of the tube was actuated by a piston within it, a joint running the whole length of the tube was necessary, and the leakage from the latter was the most serious defect of the system. In the new plan the train is within the tube, itself forming the piston against which the pneumatic pressure acts. Thus the joint is dispensed with, and the area subject to pressure being much greater in proportion to the weight of the train, a less pressure suffices, and the loss from other sources of leakage is correspondingly reduced. The compression or exhaustion of the air, as the case may be, is produced by a large centrifugal fan, which, if constructed on correct principles, will be more effective and less costly than the old plan of blowing-cylinders. Some passengers have been sent through the small tube already laid down, and there is no reason why another, say 9 or 10 feet in diameter, should not be employed expressly for passenger traffic. Indeed, the impossibility of collision or explosion, and the absence of smoke and steam, would seem to point to this as a safer, healthier, and more economical system for the underground railways of London than that adopted by the Metropolitan Company.

Armour Plates and Iron-clad Vessels.—Renewed trial has been made at Portsmouth of the laminated system of armour-plating, one modification of which is in so much favour in America. In this experiment, planks of iron 2½ inches thick were attached in two layers, crossed at right angles, so as to be equivalent in weight to 5 inches of solid plate. As in all previous experiments in this country, they proved inferior in resistance to solid armour-plate. Two bent plates were tested, with a view to ascertain the relative advantages of the hot and cold bending processes, and the extent to which they each injured the material. Both plates broke up in a most extraordinary manner, and led to serious doubts of the invulnerability of the curved portions of our iron-clads. A subsequent experiment, however, exhibited a different result, and further investigation is necessary. Steel plates have again proved failures under trial. In France, armour-plates have been pierced by flat-fronted shells, as had been accomplished previously in this country; the weight of the shells 100 lb., charge 28 lb. to 33 lb., gun of the kind known in this country as the "Blakeley."

Tubular iron tripod masts, and iron chain and wire rope, are likely to supplant timber and hemp in mail-clad vessels. They are less subject to damage from shot, less obstructive to the training of the guns, and less likely to foul the screw if shot away.

Superheated Steam.—The researches of Dr. Fairbairn and Mr. Tate on the law of expansion of superheated steam have been published, and confirm the surmise stated in a previous paper, that at temperatures considerably above the point of saturation, or at which steam is of the density which it would assume in contact with water, the law of expansion is identical with that of air and other permanent gases. Near the saturation point, the rate of expansion is much higher, and it diminishes rapidly as the temperature increases till the mean value of the constant E in the common formula becomes 458·74, that for air deduced from the experiments of Regnault being 459, and that assumed for a perfect gas by Rankine being 461·2.

Steam Sledge.—M. Routzen has matured a system of steam transit for the snow-covered roads of Northern Russia during the winter months. He employs a train of sledges, one of which carries a high-pressure engine, boiler, and windlass. The train is hauled forwards by cables attached to fixed anchorages, and the rate of progress does not exceed a mile an hour.

Aluminium Bronze, to which we have already referred, has been selected by Lieutenant-Colonel Strange as the material for the construction of the great Theodolite for the approaching trigonometrical survey of India, on account of its high tenacity (45 tons per square inch, twice that of ordinary bronze, and equal to that of steel), its great rigidity or resistance to flexure, and its unoxidability. Sterro-metal, the new alloy employed in Austria for guns, and containing $1\frac{3}{4}$ per cent. of iron, has nearly equal advantages.*

MICROSCOPY.

The Colouring Matter of the Red Sea.—Mr. H. J. Carter, of Bombay, who returned to England last June, after spending many months on the coast of Arabia, had an opportunity of seeing the colour of the Red Sea which is produced by *Trichodesmium Ehrenbergii*, an oscillatorian vegetable organism, first described by Ehrenberg in 1826. Mr. Carter describes it as a yellowish-brown oily-looking scum on the surface of the sea in large areas of many miles in extent; and once he saw a portion of brilliant red and one of intense green together in the midst of the yellow. The odour was like that of putrid chlorophyll, well known to those who have much to do with filamentous algæ. Having collected some of this scum in a bottle, by the aid of a lens he found it to consist of little short-cut bundles of filaments, like Oscillatoria. Under the microscope, specimens preserved in alcohol—the bundles in which were about $\frac{1}{50}$ in. long by $\frac{1}{100}$ in. broad—were found to contain about 25 to 60 filaments, each about $\frac{1}{50}$ in. long and $\frac{1}{2400}$ in. broad. The bundles bore no evidence of an investing sheath, but of the filaments being held together by mucus secreted from them generally. The yellow colour is most prevalent, the red next, and the green least of all. The red colour, like the green, appears to herald the termination of some period of the existence of the species, and the intense green colour he conjectures to be indicative of sporidification.

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* See also Summary of Metallurgy.

Application of Magenta Dye to Microscopical Investigations.—At a recent meeting of the microscopical section of the Literary and Philosophical Society of Manchester, Mr. Roberts called attention to the aid that might be received in the examination of the structure of animal and vegetable tissues by the use of colouring materials. Magenta is peculiarly adapted for this purpose, in consequence of its solubility in simple water, and its inert chemical character. The nuclear structures of animal cells are deeply tinted by magenta, and by its use the nuclei of the pale blood corpuscles, of pus globules, of the renal and hepatic cells, and of all epithelial structures are brought out in great beauty, tinted of a bright carbuncle red. The *red* blood discs are tinted of a faint rose colour, and a darker red speck, not hitherto noticed, is to be observed on the periphery of the corpuscle; it undergoes some changes when treated with tannin, and subsequently with caustic potash; but this point is still under investigation.

Cleaning Diatoms.—Mr. J. A. Tulk recommends the light detachment of the diatomaceous stratum on the surface of the moist or immersed mud by the aid of a small, old salt-spoon, by which means it is taken nearly free from siliceous particles. The bottle should contain a little water. If the mud be dryer, a camel's-hair pencil is useful. They should then be strained through a piece of thin silk gauze, and placed in a saucer with an eighth of an inch of water above the stratum, and exposed for a few hours to sunlight, which in many instances causes the diatoms to ascend above the impurities, where they may be known by their brown colour, and may be separated by a camel's-hair brush. In many cases boiling in nitric acid, and washing in clean water, is all that is required. If not, successive washings in a wide-mouthed bottle gets rid of a great deal of minute matter, and further boiling in sulphuric acid and chlorate of potash, and subsequent violent shaking in clean water, gets rid of flocculent siliceous matter or mucus. When the microscope shows the supernatant fluid to be clear of siliceous particles, a whirling motion given to the diatoms in a flat-bottomed saucer, half-full of clean water, brings the frustules to the surface, whence they may be removed by the capillary dipping tube.

The supposed Microscopic Jaw.—Mr. G. Busk, F.R.S., in the *Microscopical Journal*, shows reason to believe that Mr. Spence Bate's conjecture as to the crustacean origin of this pseudo-morph is not the true explanation, and gives figures of pedicellaria-valves of species of echinus, in juxtaposition with the *jaw* itself. These pedicellariæ consist of three valves, articulated in a complex manner to each other. Each valve possesses a serrated margin, large denticles on the anterior ridge, a large denticle in front of the median ridge, and lateral condyles—all of which well agree with the appearances presented by the object in question. Mr. Busk remarks that a full account and accurate figures of the varieties which exist in the pedicellariæ of various echinidæ and asteridæ, would afford a subject for a very useful and interesting paper, and might assist, perhaps, very considerably, in the discrimination of species or genera of those families. We may add that no one is so well qualified as Mr. Busk for such a task.

Thread Cells in Mollusca.—Dr. Strethill Wright shows that he had anticipated this discovery in a paper read before the Royal Physical Society of Edinburgh. Such cells were formerly supposed to be only found in the hydroid and helianthoid Polyps and the Medusæ. Professor Allman afterwards discovered them in a species of *Loxodes*, a protozoan animalcule. Dr. Wright found them in an Annelid *Spio Seticornis*, and in the tentacles of Cydippe, one of the *Ctenophora*. Since then he has observed them on the very minute tentacles of Alcinoë, another of the *Ctenophora*. In all these classes of animals the thread cells were developed within the ectodermal (or outer) coat of the animal. The type of structure also differed in the Protozoon, Hydro-medusa, and Annelid; and the thread cells discovered in Eolis resembled exactly those of the Hydro-medusæ in their structure. Mr. Alder, the greatest authority on these animals, still hesitates to assent to the doctrine, on account of its apparent extreme improbability.

Kelner's Orthoscopic Eyepiece.—Mr. Ross has brought out an eyepiece under the above name, said to possess over the Huyghenian eyepiece the advantages of a very much larger field, with more light, and yet without any sacrifice of defining quality. With a "Kelner" eyepiece you may magnify an Arachnodiscus until it appears equal to a dinner-plate in size, and yet be able to see the whole of the object.

MINERALOGY, METALLURGY, AND MINING.

MINERALOGY.

Petroleum.—Amidst the fears of the timid, the trade in this liquid mineral continues to increase with extraordinary rapidity. According to the circular of a Liverpool merchant, although the American oil was almost unknown in 1860, a total of 9,000,000 gallons was imported into Europe in 1862, and not one disaster happened in connection either with its transit or storage which would not equally have occurred to any other article of production. Recent advices from Belgium state that the Minister of the Interior has just taken occasion expressly to declare that this oil is not to be considered as one of the articles of inflammable merchandize which must be treated by special regulation as essentially dangerous. It is said that a line of steamers are to ply in the ensuing summer between New York and a British port, solely for the purpose of conveying it to Europe. A new well has recently been opened, which is said to yield 300 barrels per day; but the consumption of the article will be so great as to absorb all that can possibly be produced.

Odour of Precious Stones.—Fournet discovered that many precious stones owed their colours to carburets of hydrogen. In 1855 J. Schneider, by analysis, confirmed this discovery. In a note recently inserted in Poggendorff's *Annalen*, Schneider calls the attention of mineralogists to the empyreumatic odour which certain forms of quarts and granite give fo when rubbed. He thereby perceives the indication of the presence of organic matter or carburet of hydrogen.

Triphyline, which is a triple phosphate of lithia, manganese, and iron, has until lately been known to exist in one locality only—at Bodenmais, in Bavaria. Mr. Geo. J. Bush has recently shown that it occurs along with Spodumene at Norwich, Massachusetts.

Carnelian is a variety of chalcedony (a form of quartz), generally of a clear bright red tint, from the presence of iron. At a recent meeting of the Manchester Philosophical Society, Mr. Joseph Sidebotham exhibited a carnelian pebble, with a cavity containing a globule of water, brought from the coast of Tuscany. These pebbles, it was said, are often picked up on the shore, and, when broken, exhibit a crystalline cavity about one-third filled with water.

Connellite is another extremely rare mineral, of great beauty, which has never had a satisfactory locality assigned to it. Professor Maskelyne has recently found specimens of it in a collection of undoubted Cornish minerals. The crystals of the mineral are very minute, and the Professor, in order to measure them, combined a small telescope and a small lens with the ordinary reflecting goniometer.

Lanthanite (*Carbonate of Lanthana*).—The determination of the crystalline form of this mineral is another example of the use of polarized light. It has been hitherto supposed that it crystallizes in the pyramidal system; but M. Descloizeaux found recently, in the course of his important researches on the optical properties of minerals, that lanthanite possesses two optic axes, and the crystals of lanthanite must therefore be considered to belong to the prismatic system.

Thallium.—This most recently discovered element appears to be widely diffused in certain classes of minerals. Mr. Crookes states that upon examining a large collection of cupriferous pyrites from different parts of the world he found it present in more than one-eighth; but he has very rarely met with it in pyrites in which copper is absent. On the other hand, M. Fred. Kuhlmann says that certain specimens of pyrites which furnish thallium in quantity came from near Spa, and consisted of sulphide of iron with veins of blende and galena. The pyrites was used for manufacturing sulphuric acid; and by causing the gases to go through a supplementary chamber, before passing to the leaden chambers, deposits were obtained very rich in the new metal, and also in arsenic and selenium. By this process the sulphurous acid, and consequently the sulphuric acid, were rendered much more pure. Mr. Crookes observes that he has no hesitation in saying that in some of our large copper, sulphur, and sulphuric acid works, thallium is at the present time being thrown away by the hundredweight, whilst it might easily be saved.

Native Copper.—The largest known supplies of native copper are those on the coast of Lake Superior. Two great masses have been recently discovered in the Mesnard district, Michigan, which have excited considerable attention as evidences of the inexhaustible and wonderfully productive nature of the Lake Superior region. Little of the first mass was above the surface when first discovered, and that little was so covered with moss and small underbrush as scarcely to attract attention. Upon being uncovered traces of Indian workings were found. Two specimens were cut off, which were shown to be very compact pure copper. One of the masses found was forty feet in length by four in breadth, and weighed about fifty tons.

Native Silver.—No one would think of mining for silver in the stomach of a mule, yet in the Geological Museum there is a lump of silver "about as much as would make forty shillings," which has been taken from such a locality. It appears to be a common occurrence to find quantities of silver in the stomach and intestines of mules working in the Mexican silver mines, and its presence is accounted for by the mules eating mud, which contains much silver, for the purpose of obtaining the salt which is also mixed up with it. The silver is said to accumulate to a considerable extent without proving injurious.

METALLURGY.

The Dowlais Iron Works.—In our last number we stated that the weekly make of iron is 130 tons. It should have been added, that this is the produce of *each* of the eighteen furnaces possessed by that establishment. At present it appears to be about 150 tons per furnace, or about 2700 tons weekly for the whole establishment. In many districts the weekly make of iron per furnace varies from 250 to 300 tons.

Aluminium.—This metal has risen suddenly to a position of great importance. Although isolated by Sir Humphrey Davy, and obtained in globules by Wöhler in 1845, it was not prepared in any quantity, until within the last few years, when Deville's improvements led to its being produced in considerable masses. Messrs. Bell, of Newcastle-on-Tyne, now manufacture it largely by Deville's process, which essentially consists in the decomposition of dry chloride of aluminium by means of sodium. The metal was exhibited by this firm, and by Messrs. Morin & Co., of Nanterre (Seine), at the late International Exhibition, under the form of bars, wire, sheets, tubes, foil, castings, and forgings. It has been drawn into wire by M. Garepou, of Paris, and it is said to be from 60 to 100 per cent. cheaper than silver wire. It is exceedingly light (its specific gravity being little more than 2·5); thus, a sextant in brass will weigh 3 lb., which, if made of aluminium, weighs only 1 lb. 9 oz. Such a sextant, and also various other philosophical instruments of the same material, were exhibited by Messrs. Bell. They have recently produced a modification, which they term "whitened aluminium," in which the unpleasant zinc-like hue of the metal is obviated. They have also formed keys of aluminium, alloyed with 2 per cent of nickel, to increase its hardness. From aluminium wire and foil the lighter weights used for chemical purposes may be advantageously made, since, occupying something like seven times the space of those of platinum, they are more easily adjusted and handled, and less likely to be lost. MM. Collett, of Paris, have constructed a chemical balance, in which every part, down to the milled head by which the beam is released, is made of aluminium. It would appear, however, that this metal is destined to be more useful as a constituent of alloys, than in the unalloyed form.

Aluminium Bronze is a beautiful alloy of copper and aluminium. Various articles made of it were shown in the International Exhibition; they attracted much attention, especially some watch-cases made by Messrs. Reid, of Newcastle, which so closely resembled gold as not to be distinguished from it by experienced persons. Aluminium bronze is made of three qualities—the first containing 10, the second 7½, and the third 5 per cent. of aluminium, the rest being copper. These varieties are scarcely to be distinguished from gold, except by their specific gravity, which is scarcely half that of the precious metal. They tarnish much less readily than any metal usually employed for astronomical instruments, viz., gun-metal, brass, silver, cast-iron, or steel. In making the alloy, extremely pure copper must be used. The best is that deposited by electricity, but that kind is very expensive; the next best is native copper from Lake Superior.

Fusion of Steel in large Masses.—M. Sudre has succeded in melting large quantities of steel in a reverberatory furnace, the steel being preserved from oxidation and from change of properties by a covering of slag, such as may be obtained from charcoal melting furnaces, or common bottle-glass.

The Spectroscope in Steel-Casting.—It is said that a practical application is likely to be made of spectrum analysis in the fusion of steel, by the examination of the gases evolved from the melted metal, which will enable the workmen to detect the point at which the required effect is produced, and so to arrest the operation at the right moment.

Properties of Steel.—Mr. David Kirkaldy has found that the same piece of wrought iron or steel, on being broken, may present a fibrous or a crystalline fracture according to the rapidity with which the fracture takes place; and hence there is no such change as is commonly supposed to take place in the metal, from a fibrous to a crystalline condition when subjected to vibration. He also found that steel is reduced in strength by being hardened in water, while the strength is vastly increased by being hardened in oil.

Mr. Charles Bathoe, states that in India glaziers never use a diamond to cut glass, but they do all their work with a hardened steel point. He has himself hardened steel so that it was as brittle as glass, by plunging it at nearly a white heat into iced water.

Captain Caron, Director of the French Imperial Laboratory, has experimented upon the formation of steel and the result of tempering. He regards the latter as in effect analogous to the blow of a hammer, but more potent, because acting in every direction at once. It causes a more intimate union between the carbon and the iron. The more suddenly the cooling takes place in the process of tempering, the stronger is the effect produced.

Applications of Steel.—At a late meeting of the South Wales Institute of Civil Engineers, Mr. Parry, of Ebbw Vale, stated that steel rails laid down on the Midland Railway nearly six years ago, over which trains have since passed 700 times daily, are to this hour uninjured. They were made by Mr. Mushet's process.

Steel-wire ropes are now extensively used in winding minerals from mines, gradually displacing those of iron wire, which, to have the same strength, require to be very much thicker and therefore heavier than those of steel.

Sulphuretted Hydrogen in the Reduction of Copper.—It has been discovered that this gas may be prepared in large quantities, from the ignition of pyrites under certain conditions. The process is now adopted in Norway, and applied to the separation of copper from poor cupriferous pyrites.

Copper Ore in Cheshire.—At Alderley Edge, is a very singular deposit of copper ore which has impregnated sandstone. Although the percentage of copper in the sandstone is not more than 1¼, yet, by the methods of reduction practised, the copper is separated with profit on an extensive scale. The average yield of the mines is 25 tons of copper precipitate monthly; and the profits have reached to some thousands of pounds yearly. Mr. George Henwood, who lately inspected the works, describes the process adopted. It consists in grinding the stone, and then submitting it to the action of hydrochloric acid for eighteen or twenty-four hours, when all the copper will be extracted and the sand made perfectly white. The liquor is drained off, and scrap iron placed therein, which soon precipitates all the copper, the precipitate is washed and dried, and is then ready for the market.

MINING.

Mineral Statistics.—In the paper of Mr. Robert Hunt, already referred to, we find various statistics of the mineral products of the United Kingdom for 1861. They have also appeared in a separate form.

Number of collieries	3,052
Quantity of coal raised...	83,635,214 tons
Value	£20,908,803
Lives lost annually in coal mines ... about	1,000

In the ten years ending 1860 the number of lives lost was 9,090.

Total value of metals produced from British minerals in 1861...	£13,693,550
Coals	20,908,803
Total value of mineral produce	£34,602,353

Amongst the metals, gold appears for the first time to the extent of £10,816, being the production of the Merionethshire mines.

The value of the silver extracted from lead ore raised in the United Kingdom in 1861, was £144,161.

In Great Britain there are 336,000 persons actually engaged in mining operations, exclusive of those in quarries of all kinds. Of these 250,000 are coal miners. Probably not more than 300 of the whole number are receiving any such course of instruction as is necessary to fit them for the labours for which they are destined.

Boring by Diamonds.—Some time since it was suggested that black or rough diamonds might be employed for the perforation of hard rocks. This suggestion has been put into practice by a French engineer, M.

Leschol. The instrument he uses is made out of a tube furnished with a circular cutter of rough diamonds.*

Mining by Machinery.—Very little has yet been done to supersede manual labour in the excavation of mineral substances, but the matter is now beginning to receive attention. In metallic mines, Crease's excavating machinery is said to be highly successful. The inventor engages that such machines, fitted with two augers, shall work at the rate of 500 to 700 blows per minute, each auger independent of the other, and working at any angle whatever.

Attempts have been made at various times to arrange machinery for getting coals, but until very recently none has stood the test of experience. It will be necessary to explain that in getting a seam of coal, the first operation is usually that called "holing," or "undercutting," which consists in making a horizontal excavation into the coal at the base of the seam by means of the pick. It is in this process that the chief labour of coal-getting consists; and whoever has seen half-naked colliers engaged in this toil, kneeling, or perhaps lying on their side, must feel that it is very desirable to substitute machinery for such terrible work. Some years ago a coal-cutting machine was invented by Mr. Peace, of the Earl of Crawford's Collieries, Wigan, in which an endless chain, provided with teeth, was made to revolve; but it has long been disused. A machine has lately been invented, however, which is at present employed at the West Ardsley Colliery, near Leeds, and which bids fair to be very successful. It may be briefly described as a collier's pick in the hands of a machine. The pick is made to act in any direction; but for holing it will, of course, strike horizontally. The handle of the pick forms the long arm of a "bell-crank," of which the shorter arm (which moves through a much smaller space) is actuated by the piston of a cylinder. To work the latter, compressed air is forced in pipes down the pit to the cylinder, and moves the piston just as steam would do, but with the advantage that the escape air assists in the ventilation of the working place. The whole machine is mounted on wheels, and can be run on tramways from place to place.

PHOTOGRAPHY.

THE adjudicators appointed by the Council of the Photographic Society have awarded the prize medals for the best contributions in six distinct branches of photographic art, as follows:—

M. Claudet, for the best portraits.
Mr. Francis Bedford, for the best landscapes.
Colonel the Honourable Stuart Wortley, for the best instantaneous pictures.
Viscountess Hawarden, for the best amateur contribution.
Mr. H. P. Robinson, for the best composition picture from life.
Mr. Thurston Thompson, for the best reproduction.

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* A description of it will be found in our Continental Summary.

It is to be hoped that the rewards offered this year for the first time may serve as a stimulus to increased exertion on the part of the contributors to future exhibitions of the Photographic Society.

His Majesty the Emperor of the French has bestowed the cross of the Legion of Honour upon three photographers whose productions were most deserving of attention in the late International Exhibition; viz., M. Bayard, for useful photographic inventions; M. Duboscq, for improvements in optical instruments; and on M. Poitevin, for his inventions in carbon printing and photo-lithography.

The premium of 2,000 francs offered, in the year 1856, by the Duc de Luynes, for the best method of printing in carbon, has ultimately been divided into four minor prizes, and bestowed as follows:—A gold medal of the value of 600 francs was given to M. Poitevin, as the originator of the first idea upon which the carbon printing processes were based; viz., the peculiar action of light upon a combination of organic matter with salts of chromium. The merit of this invention appears, however, to rest with Mr. Mongo Ponton, who as far back as May, 1839, communicated to the Royal Scottish Academy of Arts his discovery of the action of sunlight upon paper steeped in a solution of the bichromate of potash. The second gold medal, of equal value, was bestowed upon MM. Davanne and Girard for their researches into the causes of the fading of silver prints. A silver medal valued at 400 francs was awarded to Messrs. Garnier and Salmon, for their process of printing in carbon; and a similar medal was given to Mr. Pouncey, of Dorchester, for his invention of the same character. Subsequently the reward conferred upon M. Poitevin has been augmented by 2,000 francs, and an additional medal presented to M. Fargier for his process.

The practical photographer is indebted to M. Meynier for two valuable suggestions. The first refers to the use of the double sulphate of iron and ammonia as a developing agent. The aqueous solution of this salt possesses the advantage of greater permanence, whilst as a reducing agent it is eqally efficient with the simple sulphate. Several distinguished operators have pronounced very favourably upon the capabilities of this salt as readily giving exquisite half-tone with a proper amount of intensity in the high lights. It is manifestly requisite to employ such a larger proportion of this salt as will compensate for the diminished amount of actual protoxide of iron in the compound; a solution containing 25 grains of the double sulphate, with 25 minims of acetic acid to the ounce of water, is stated by Mr. G. Wharton Simpson to give excellent results. The second suggestion, offered by M. Meynier, has reference to the employment of the sulpho-cyanide of ammonium as a fixing agent, both for negatives on glass and prints upon paper. This compound has the property of dissolving both the iodide and chloride of silver, forming solutions which are not liable to the deposition of the black sulphide on heating or standing at rest for some time. The proposition has been made the subject of experiment, and reported upon by Mr. Spiller, who states that this re-agent is the only one known to have the power of removing the whole of the silver from the preserved white portions of albumenized prints, and that the cost of this article constitutes its only disadvantage. MM. Davanne and Girard have more recently confirmed the favourable opinion expressed by Mr. Spiller.

A very ingeniously-constructed microscopic camera has recently been introduced by Mr. A. F. Eden, of Crown-court, Threadneedle-street. It is made to serve a variety of purposes, and can be used either for taking reduced copies of photographic pictures or direct miniature portraits from nature, to be examined afterwards by the aid of an ordinary microscope; or may be employed inversely for the production of magnified representations of microscopic objects. The instrument may be described as consisting of a photographic camera adapted to the body or tube of an ordinary microscope; and, although the combination serves the purposes already enumerated, the two portions may be disconnected, and each used separately. Thus, to the mahogany camera may be adapted a landscape lens of about sixteen inches focus, when it becomes suitable for copying and for taking small views on plates of sizes up to seven inches square; likewise the optical portion of the instrument may be mounted on a brass stand, and requires merely an eye-piece to constitute an effective compound microscope. The manner of using the instrument may be briefly described. Supposing it be required for taking a micro-photograph, or reduction from an ordinary negative, the latter is supported in the position usually occupied by the ground-glass, or dark side in a camera of the usual construction. This end of the instrument is provided with a large plane reflector attached by a hinge, and capable of adjustment to any angle which may be required to direct the rays of the sun or diffused daylight through the negative and axis of the camera. By means of the microscope object-glass in front of the camera, a sharply-defined image is depicted upon the screen of a little dark box placed a short distance beyond. The lens may be adjusted and focussed by the aid of a rackwork and pinion movement; and when the optical perfection of the image is deemed satisfactory, the scratched glass is exchanged for the sensitized plate, in this instance represented by a single drop of collodion upon a slide of standard dimensions—one by three inches. The exposure will not usually exceed ten seconds in bright daylight, and the development occupies but a single moment, since it is advisable to guard against too great intensity in the minute photographic reproduction, in order that the speck of reduced silver on the glass may exhibit under assisted vision its proper gradation of light and shade. The beauty of the result, and the rapidity with which the whole process is executed, will possess a charm for those whose leisure moments are scarce, and whose laboratory facilities are of a limited character. On the other hand, by placing in the little dark box a microscopic object mounted on a glass slide, and removing the cap or stopper which prevents the access of daylight, an enlarged and well-defined image will appear upon the ground glass at the larger end of the camera. Having focussed in the same manner as before, this image now presents itself ready to be photographed, on merely holding the camera properly to the sun, or reflecting its rays from the small concave mirror placed at this extremity of the instrument. And further, by removing altogether the larger mirror the apparatus will be suitable for taking miniature portraits of sizes varying from that of a grain of mustard seed to such as would be mounted in a small locket. The one-inch lens is that preferred for general use, but a lower power is also provided. Both of these object-glasses have their photographic and optical foci coincident; no allowance need therefore be made in the adjustment of the sensitive plate; and the fact that Mr. Eden was for some years a pupil of Mr. Andrew Pritchard is so far a guarantee for the perfection of the optical part of the microscopic camera.

PHYSICS.

PROFESSOR W. A. MILLER, of King's College, London, has published in the Proceedings of the Royal Society an abstract of an important investigation "On the Photographic Transparency of various Bodies, and on the Effects of Metallic and other Spectra obtained by means of the Electric Spark." The first portion of his paper refers to the absorbent action of various media upon the *chemical* rays of the electric spark, the spark or light being obtained between two metallic wires (generally of fine silver) connected with the ends of the secondary wire of a strong induction coil. The light was first passed through a narrow vertical slit in a piece of metal, then through the substance to be examined, which, if a liquid, was contained between two thin plates of polished rock-crystal, then through a quartz prism placed at a suitable distance, immediately upon this, through a lens of rock-crystal; and at a suitable distance the spectrum was received upon a sensitive collodion surface in a camera. His experiments with *gaseous* substances were made by interposing in the track of the ray, between the vertical slit and quartz prism, a brass tube, two feet long, closed at each end, air-tight by means of a plate of quartz, and each gas or vapour was introduced separately into the tube.

His general results were:—1st. That colourless bodies which are equally transparent to the visible rays vary greatly in permeability to the chemical rays; 2nd. Bodies which are photographically transparent in the solid state preserve their transparency in the liquid and gaseous states; and 3rd. Colourless transparent solids which exert a considerable photographic absorption, generally preserve that power when converted into liquids or gases, and it makes no difference whether they are liquefied by means of heat or by being dissolved in water. He employs the term "diactinic" to express the power which bodies possess of transmitting the actinic or chemical rays.

The experiments upon gaseous bodies gave important results, showing, however, but little coincidence with those of Tyndall on the absorbent power of gases for radiant heat. Amongst the colourless gases, atmospheric air, oxygen, hydrogen, nitrogen, carbonic oxide, and carbonic acid, exert no absorbent power; olefiant gas, nitrous oxide, cyanogen, and hydrochloric acid slightly absorb the chemical rays; whilst with coal gas the more refrangible half of the chemical spectrum was entirely cut off. Then follow, with increasing power, sulphurous acid, bisulphide of carbon, and terchloride of phosphorus. Atmospheric air saturated with vapour of benzol absorbs the chemical rays more powerfully than coal gas, but if the vapour of ether, chloroform, or oil of turpentine, was substituted for that of benzol, the effect was much less marked.

Of eighteen different liquids water was found to be the most freely diactinic, and though eminently transparent to the chemical rays, it is less so than atmospheric air and certain other gases. Absolute alcohol is next, but exhibits a considerable falling off. Then follow Dutch liquid, chloroform, ether, benzol, glycerine, fousel oil, wood spirit, oxalic ether, acetic acid, oil of turpentine, glycol, carbolic acid, liquid paraffin, and bisulphide of carbon; whilst terchloride of phosphorus and oxychloride of phosphorus, although perfectly limpid and colourless to light, absorb all the chemical rays. Saturated solutions of potash, soda, phosphoric acid, and arsenic acid, exert considerable absorbing power.

Of solids, the most perfectly diactinic are rock-crystal, ice, and white fluor spar, though less so than atmospheric air and certain other gases. Rock-salt is nearly equally transparent. Then follow the sulphates of baryta, lime, and magnesia, and those of the alkalies. The carbonates, borates, phosphates, and arseniates, of the alkalies and alkaline earths, are also tolerably transparent. Although the sulphates are generally freely transparent, the sulphites are much less so, and the hyposulphites absorb about three-fourths of the length of the spectrum, leaving only the less refrangible portion. The chlorides and bromides of the alkalies and alkaline earths, and soluble fluorides, are freely diactinic, but the iodides are much less so. Amongst the salts of inorganic acids the nitrates are the most powerful in absorbing the chemical rays, a solution of either of them absorbs all the more refrangible rays and reduces the chemical spectrum to less than one-sixth of its ordinary length. The chlorates have a much less powerful absorbing action. Organic acids and their salts strongly absorb the more refrangible rays in the following order: citrates, acetates, tartrates, and oxalates, the latter being the strongest. The different varieties of sugar are freely transparent.

The second portion of Dr. Miller's paper treats of the Electric Spectra of the Metals. All the ordinary, and many rare metals were employed, and in all the experiments the image of the spectrum was received and fixed upon a photographic surface. In many cases, metals which are allied in chemical properties exhibit a certain similarity in their spectra; for instance, iron, cobalt, and nickel; also bismuth, antimony, and arsenic. Volatile metals generally give the strongest lines. Some of the experiments were made with the metallic electrodes immersed in various gases, and it was observed that certain gases, such as hydrochloric acid, sulphurous acid, and nitrous oxide, greatly resisted the passage of the electric sparks.

A valuable paper on the stratified appearance in Electrical Discharges, by J. P. Gassiot, F.R.S., has been printed in Number 53 of the Proceedings of the Royal Society. He describes numerous experiments with a battery consisting of 3,360 pairs of plates, acting upon various rarified gases, in glass tubes; and especially examines "the effects obtained by varying the resistance." He states that the stratified discharge from a *single* disruption of the primary wire of an induction coil, is identical in character with the continuous discharge of a voltaic battery. The form and positions of the striæ appear to depend upon the power of the battery, and upon the state of tension of the rarefied gases. The number of striæ appears to indicate the degree of tension in a closed battery circuit, as a gold-leaf electroscope does in an unclosed circuit, and can be regulated by introducing different amounts of resistance into the circuit. The number of striæ decreased as the amount of resistance introduced into the circuit was increased; but at the same time the striæ assumed a different shape, and the bright and dark portions at the tube occupied different positions.

Reitlinger has put forward a new explanation of stratified electric light, as seen in rarefied media. He supposes that in a tube filled with rarefied aqueous vapour, the hydrogen and oxygen are disposed in alternate layers, and that the oxygen being a worse conductor of electricity than hydrogen, becomes much more heated, and thereby much more luminous, and thus produces dark and bright bands. In support of this view, he states—1st, that no stratification has been produced by elementary and unmixed gas; and 2nd, that the vapour of mercury alone gives only a white light, without stratification, but immediately on adding a few bubbles of air to it, dark bands appear.

An abstract of a paper, "On the Long Spectrum of Electric Light," read before the Royal Society, by Professor G. G. Stokes, F.R.S., has been published in the Proceedings of the Royal Society. He employed as the source of light the spark of an induction coil, with a Leyden jar connected with the secondary terminals; and examined the light evolved by electrodes of different metals. He found light from aluminium electrodes the richest in invisible rays of extreme refrangibility, and therefore used that metal when examining the behavour of those particular rays. This portion of the spectra of the metals may be viewed by means of fluorescence, and its mode of absorption by different liquids also observed by the same means. He finds that solutions of alkaloids and glucosides are usually very opaque to those rays, and some of them produce bands of maximum opacity in particular parts, highly distinctive of the special substance under examination. In natural crystals of adullaria and felspar, generally a strong fluorescence is produced by these invisible and highly refrangible rays. A particular variety of fluor-spar shows a decided reddish fluorescence under the exclusive influence of rays of the very greatest refrangibility, and will therefore form a valuable means of detecting those rays.

In the "American Journal of Science and Arts," January, 1863, is a paper, "On the Equivalent and Spectrum of Cæsium," by S. W. Johnson and O. D. Allen. It professes to contain a more extended description of the lines composing the cæsium spectrum than that given by Kirchoff and Bunsen, and states that it is the most beautiful of all the spectra of the alkali and earth metals.

M. Janssen has described in the Comptes Rendus some new spectroscopes: the first is one with direct vision, it unites great dispersive power with simplicity of construction, and seems well adapted for optico-chemical analysis; the second is a pocket instrument, forming a small folding glass, and is also adapted for direct vision, by means of it the solar spectrum can be seen in the feeblest and most diffused light; but it is more specially adapted for the analysis of flames. A new form of spectroscope has also been described by Dr. Wolcott Gibbs, in the "American Journal of Science," vol. xxxv., page 110.

An abstract of a paper, "On the Reflection of Light from Polished Surfaces," by Rev. S. Haughton, F.R.S., has appeared in the "Proceedings of the Royal Society." The following are some of the conclusions arrived at. That silver is the only substance which possesses the qualities of *brilliancy* and *lustre*. Of the metals which have high *brilliancy* and little *lustre* may be named mercury, palladium, zinc, and iron. Of those which have high *lustre* and little *brilliancy* there are only two, gold and copper.

A paper, entitled "Some Remarks upon Light," has been read by Mr. B. S. Proctor before the Microscopical Society of Newcastle-upon-Tyne. The author shows that substances usually considered opaque, such as ordinary white lead, &c., are not so; but that, as a rule, in white powders, pretty free transmission of light takes place through the individual particles. He examines the question, why some substances, such as white lead, when mixed with oil, possess a greater "body," or opacity, than other substances, such as magnesia, which appear equally opaque in the dry state; and shows that, in the latter case, it is because the refractive power of the substance is nearly allied in degree to that of the oil, whilst in the former case it is very different, and with white lead much higher than that of the oil. The opacity of bodies was also further examined, and it was shown that no definite line could be drawn between transparent and opaque bodies, all were transparent in some slight degree when reduced to a very thin film; and each then showed its own peculiar colour: thus gold and copper appeared green, silver violet or purple, arsenic brown, iodine red-brown, antimony and charcoal grey, &c.

Mr. H. Treppass has exhibited at the Royal Institution a new optical instrument, called a charimorphoscope. It contains improvements upon the kaleidoscope of Sir David Brewster, the effects being under the control of the operator, who is thus able to produce in relief, delicate or simple, gorgeous and elaborate patterns, according to his own fancy.

Dr. Tyndall, in a paper "On the Absorption and Radiation of Heat by Gaseous Matter," in the "Philosophical Magazine," describes what he terms "dynamic radiation and absorption," or the radiation and absorption of heat by gases and vapours without any source of heat external to the gaseous body itself. The method he adopts is to admit a minute portion of the gas to be examined into the exhausted tube of his apparatus for determining the degree of transparency of gases for heat, and then allow dry air to enter the tube and mix with it; the gaseous mixture thus increasing in density becomes slightly heated. In the case of boracic ether he found that the radiation of an amount of vapour possessing a tension of less than a thousand-millionth of an atmosphere was perfectly measurable. The absorbent action of perfumes and essential oils for heat was also examined; and, in the instances of spikenard and aniseed, it was found to be upwards of 350 times that of dry air. He further examined the thermic absorption of electrolytic oxygen, *i.e.*, ordinary oxygen containing ozone, and found that, in proportion as the size of the electrodes which evolve the oxygen was diminished, the proportion of ozone in the gas increased, and its thermic absorption also increased, until it amounted to 136 times that of ordinary oxygen ; but even in this experiment the quantity of ozone operated with was perfectly unmeasurable by ordinary means. He considers, for the present, that ozone is produced by a packing of the atoms of ordinary oxygen into oscillating groups, and that heating dissolves the bond of union, and allows the atoms to swing singly, and thus converts ozone into ordinary oxygen.

A paper was also recently read by the same author at the Royal Institution, "On Radiation through the Earth's Atmosphere." In a former communication he showed that the aqueous vapour in the air absorbed a vastly greater proportion of heat than did the air itself, although the aqueous vapour was only in the proportion of 1 to 199 parts of the other ingredients of the atmosphere. Several objections had been made to this result, and he now discussed those objections, and showed, in various ways, that watery vapour is opaque in an extraordinarily great degree to such rays of obscure heat as are emitted by the earth after it has been warmed by the sun, and that more than ten per cent. of the terrestrial radiation of heat from the soil of England is stopped within ten feet of the surface of the soil. The contents of this paper are similar to that of one by the same author recently read before the Royal Society, the object of which was to prove to meteorologists that they may apply, without misgiving, the results which the author had previously announced, regarding the relation of aqueous vapour to radiant heat.

M. Dufour, in the "Comptes Rendus," describes some new experiments upon the degree of rapidity of combustion of fuses under different pressures of the atmosphere. His experiments were made in the open air, and the difference of pressure was obtained by igniting them at different elevations on the Alps. His results confirm those of Quartermaster Mitchell and Professor Frankland, each of whom found that the rapidity of combustion increased with the increase of pressure.

Mr. T. H. Hill has presented to the Royal Institution some specimens of woods which had been charred by exposure to a temperature not exceeding 250° Fahrenheit, the heat being generated by steam pressure of about 10 or 12 pounds per square inch.

ZOOLOGY.

The Controversy concerning the Brains of Man and the Apes.—This has assumed a somewhat new aspect, from the appearance of an account of it given by Sir Charles Lyell, in his recent work on the "Antiquity of Man," where he states that in 1862 Professor Owen (in his paper before the British Association), "without alluding to the disclaimer of the Dutch Anatomists of their defective plates, observes that in the gorilla *the cerebrum extends over the cerebellum, not beyond it ;* correcting the description of the same brain given by Professor Owen in 1861, 'in which a considerable part of the cerebellum of the gorilla is represented as uncovered.'" Professor Owen takes exception to this statement of the case, as leading to the inference that, in regard to the same brain, he represented it as showing one structure in 1861, and another in 1862; and in a lengthy letter addressed to the *Athenæum* he endeavours to explain the circumstances. Sir Charles Lyell, in reply, expressing every desire to retract any exaggerated statement which he may have made, admits only one unimportant error, and, quoting from the published reports of Professor Owen's papers, confirms his original statements. These letters have also called forth others from Professor Rolleston of Oxford, and Mr. Flower of the Royal College of Surgeons. The former takes exception to three points referred to in Professor Owen's letter, and the latter is adduced by Sir Charles Lyell as a witness on his own behalf, to prove that the representation of the brain of a chimpanzee put before the public by Professor Owen in support of his views was an inaccurate one, in which the hemispheres had so glided apart that one was actually a quarter of an inch longer than the other, and that the figure was thus distorted, and the two dimensions of each hemisphere were not given.

The Ape-Origin of Man.—The supporters of this doctrine will be delighted with the conclusions enunciated by Professor Huxley, in his work just published on "Man's Place in Nature," who says that the sagacious foresight of the great lawgiver of systematic zoology, Linnæus, becomes justified, and a century of anatomical research brings us back to his conclusion that man is a member of the same order (for which the Linnæan term *Primates* ought to be retained) as the apes and lemurs. Professor Huxley, however, admits a chasm between man and the ape, which it would be no less wrong than absurd to deny; but it is at least equally wrong and absurd to exaggerate its magnitude. Although, however, the anatomical test is of such a character that Wagner, in his paper on the structure of the brain in man and monkeys (in the Archiv. fur Naturgeschichte, 1861), did not meet the objections of Huxley; though always remarking that Man is distinct from the Quadrumana, the objections brought forward by Huxley tend rather against the separation of Man in the special division assigned to him (viz., Archencephala) than against the separation itself.

Population of the Globe.—The *Abeille Medicale* gives some curious statistics upon this point from the most recent calculations. The earth is inhabited by 1,288 millions of inhabitants—viz., 369 millions of Caucasians, 552 millions of Mongolians, 190 millions of Ethiopians, 1 million of American Indians, and 200 millions of Malays. All these speak 3,064 languages, and profess 1,000 different forms of religion. The number of deaths per annum is 333,333,333, or 91,954 per diem, 3,730 per hour, 60 per minute, or *one per second;* so that at every pulsation of our heart a human being dies. This loss is compensated by an equal number of births. The average duration of human life throughout the globe is thirty-three years, but one-fourth of the population dies before the seventh year, and one-half before the seventeenth; but of 10,000 persons, only one reaches the hundredth year, while one in 500 attains the eightieth, and one in 100 the sixty-fifth.

Psychical Distinction of the Races of Man.—Mr. R. Dunn read a paper before the Ethnological Society upon this subject, maintaining that the genus *Homo* was one and distinct, and that the study of the cerebral organization and development of the various typical races was one of the most effectual means of better understanding and elucidating the psychological differences which characterize them. The Sandwich Islanders have excellent memories, and learn by rote with wonderful rapidity, but will not exercise the thinking faculties. It was found practically that negro children could not be educated with white children. In these cases the cognate faculties have not reached a complexity equal to the complexity of the relations to be perceived; and moreover this is not only so with the purely intellectual cognitions, but it is the same with the *moral* cognitions. In the Australian language there are no words answering to "justice," "sin," "guilt." Amongst many of the lower races of man, acts of generosity or mercy are utterly incomprehensible—facts which the author thought were in accordance with what might have been anticipated from the organic differences of the higher psychical activities.

Anthropological Society.—From the above paragraphs it will be seen that the science of *Man* is one at the present time much studied, and a new society under the above title has just been formed, with Dr. James Hunt as president, and Mr. C. Carter Blake as secretary. The society meets at 4, St. Martin's-place, on alternate Tuesday evenings.

The Unicorn of the Ancients.—Dr. Brehm, the African traveller, speaks thus of the unicorn: "Also in the interior of Africa, where I have travelled, the 'unicorn' (*Anasa* of the natives) is nothing more than the rhinoceros." The Rev. W. Houghton, in the "Annals of Natural History" for December, quoted Ctesias as describing unicorns under the name of *wild asses*, of whose horns drinking cups were made, of such virtue that those who drank from them were said to be subject to neither spasm nor epilepsy, nor to the effects of poison. Dr. Brehm remarks that, at the present day, in the interior of Africa, for example, at Carthum (Khartoum) drinking vessels and cups are still made from the horn of the rhinoceros, to which they attribute the very same properties as Ctesias did.

Preservation of Birds.—While the English farmer is energetically destroying small birds on his farm, the New Zealand farmer is making great efforts to obain a supply of such birds on his, for the purpose of destroying the insects which ravage his crops. The Acclimatisation Society of New Zealand are doing all in their power to promote the introduction into the colony of English field birds. The undermentioned amounts will be paid by the Society upon the delivery in Auckland, in a healthy condition, of a cock and hen of the following birds:—Blackcock (or grouse), cock and hen, 10 guineas; silver pheasants, ditto, £5; nightingales, £5; English partridges, £4; cuckoos, £3; missel thrushes, £2; common thrushes, £2; blackbirds, £2; starlings, £2; skylarks, £2; rooks, £2; crows, £2; jays, £1. 10s.; robins, 30s.; wrens, 30s.; bullfinches, £1; grey linnets, 15s.; green linnets, 15s.; sparrows, 15s.; goldfinches, 15s.; English quails, £1.

Walking Fish.—An observer in Province Wellesley, passing along during a shower of rain over the wide sandy plain which bounds the sea in the neighbourhood of Panaga, witnessed an overland migration of a fish much resembling the tench, called Ikan Puya, from a chain of fresh-water lagoons lying immediately within the sea beach, towards the second chain of lagoons about a hundred yards distant inland. The fish were in groups of from three to seven, and were pursuing their way in a direct line towards a second chain of lagoons at the rate of nearly a mile an hour. When disturbed, they turned round, and endeavoured to make their way back to the lagoon they had left, but were caught by the Malay accompanying the observer. Upwards of twenty were taken during a walk of about half a mile. The ground these fish were traversing was nearly level, and only scantily clothed with grass and creeping salsolaceous plants, which offered very slight obstruction to their progress.

Immense Shoals of Flounders.—Illustrating the proverbial teeming life in the sea, a person writing from Göthenburg states that "there have been caught after the late storms on the coast of Denmark a quantity of flounders, estimated at two millions and a half in number, and they say the sea is literally full of them. They do not know what to do with any more they may take, though there is a salting establishment in full work already. Five hundred men were employed night and day for three weeks in catching these fish."

New Silk Moth.—The *Revue de Zoologie* says that the Minister of Agriculture in France has received from Japan living eggs of the oak silkworm, or *Bombyx Yama-Mai*, which it is hoped may be cultivated in the Jardin d'Acclimatation. Up to this time no European had been able to obtain this precious silkworm, all attempts having been hitherto met with a flat refusal, on the ground that the exportation of them was forbidden on pain of death. Young oaks in the South of France, Italy, and Algeria are in process of being forced in order to afford food to the precious insects, which it is expected will soon be excluded from the eggs.

Acclimatation of Sponges.—M. L'Amiral, who has been to the coast of Syria with a view to obtain sponges for transplantation, has returned, and presented a detailed report to the Société d'Acclimatation. He distinguishes three kinds of sponge for which there is a demand,—a fine soft sponge, a fine hard kind, and the common sort. These sponges are found in the Levant, between Alexandretta and Saida. When first gathered at the bottom of the sea, the sponge is covered with a black but transparent gelatinous substance, resembling vegetable granulations, among which microscopic white and oviform bodies may be distinguished, which are the larvæ. When arrived at maturity they are washed out by the sea water which incessantly flows through the sponge, and then swim along by the aid of cilia, until they attach themselves upon some rock and commence a new life. This emigration of larvæ occurs about the end of June and beginning of July. The fine qualities of sponge are chiefly found at a depth of fifteen fathoms, and the common sponges lie between twenty and thirty fathoms. At Tripoli (in Syria), divers were engaged and collected sponges, which were placed in boxes, through which a stream of sea water was made constantly to flow. These arrived at Marseilles on June 17th and thence they were taken to Toulon and the islands of Hyères, where stone troughs, with five sponges in each, were sunk in different places. The success of the experiment will not, of course, be known till next season.

THE ANTIQUITY OF MAN.

BY J. R. LEIFCHILD, M.A.

HOW long has man been a tenant of this earth which he is now so rapidly subduing and so extensively populating? What was the probable geological epoch in the shadowy past when he first made his appearance here, as the last of a grand series of animals created to succeed each other in ordained and typical sequence? This question has recently been rendered universally interesting by the book of Sir Charles Lyell, although it had been agitated amongst geologists for some years. While the common opinion has always been that man first inhabited our globe about four thousand years before Christ, or nearly six thousand years ago, a few far-sighted observers saw reason for arriving at a very different conclusion; and Dr. Schmerling, M. Boucher de Perthes, Dr. Falconer, and Mr. Prestwich, have during recent years severally investigated the geological evidences of man's great antiquity in different localities until each and all of them have admitted and advocated it.

A succinct and popular notice of the evidences for such human antiquity may be acceptable to our readers, divested of technicalities and condensed within moderate limits.

The evidences derived from the actual presence of human bones, but more commonly of works of human art in caves, first claim our attention; and of these the discoveries of Dr. Schmerling were both earliest in time and most decisive in character. In caverns in the limestone which rises up along the banks of the Meuse, this persevering geologist disinterred unquestionable human bones from two or three localities, and a now celebrated skull from the Engis cave. Much discussion has been held over and about this skull, as respects the race of men to which it belonged. The most recent and the clearest observations upon it have been made by Professor Huxley, from which we may present the following paragraph:—

> I can find no character in the remains of that cranium which, if it were a recent skull, would give any trustworthy clue as to the race to which it might appertain. Its contours and measurements agree very well with those of some Australian skulls which I have examined, and especially has it a ten-

dency to that occipital flattening to the great extent of which in some Australian skulls I have alluded. But all Australian skulls do not present this flattening, and the supraciliary ridge of the Engis skull is quite unlike that of the typical Australian. On the other hand, its measurements agree equally well with those of some European skulls, and assuredly there is no mark of degradation about any part of its structure. It is, in fact, a fair average human skull, which might have belonged to a philosopher, or might have contained the brains of a thoughtless savage.

Another human skull was discovered, in 1857, in the Neanderthal valley, near Düsseldorf, in Germany, and it is probable that the whole skeleton was originally preserved, although destroyed by the workmen, excepting some fragments of the larger bones. This is the most ape-like in its shape of any known human skull. Its capacity, however, is estimated as equal to seventy-five cubic inches, which is about the average capacity of present Hottentot and Polynesian skulls. In no sense, then, except mere shape, is the Neanderthal skull ape-like, and in no sense can it, with the accompanying bones, be considered as having belonged to a race of men intermediate between human beings and the apes. Though lower in type than the Engis skull, the Neanderthal man was, in all probability, nearly of average European size and stature.

These human remains are thought to be amongst the oldest at present known; and Dr. Schmerling, about thirty years ago, expressed his belief that they belonged to men who were contemporary with the quadrupeds of extinct species whose remains were found with them. This view was totally dissented from by Dr. Buckland, although he had nearly convincing evidence of its truth under his own eye when he was an explorer of the cave of Paviland, on the coast of Glamorganshire. There he saw a human skeleton, and the remains of recent testacea of eatable species which may have been carried in by the man himself when alive. There also were found numerous bones of animals, the entire mass of which appear to have been disturbed by ancient diggings, so that the remains of extinct animals had become mixed with recent bones and shells.

The instances in which works of human art have been discovered in caves are more numerous than those in which human bones have occurred. In England, we specially notice the "Wokey Hole hyæna den," in Cheddar cliffs, near Wells, Somersetshire, which but for a fortunate incident might have remained unknown for centuries longer. It had been fi [illegible] the roof with *débris*, stones, and organic rem [illegible] suspected its existence as a cave u [illegible] s directed to it. It was then found to be a rich repository of curious remains. In three areas of this cave were found ashes of bone, and especially of the extinct woolly species of rhinoceros, associated with flint or chert implements of the same type as those found near Amiens and Abbeville, though they were ruder, and therefore, in all probability, of earlier date. They were found near *underlying* layers of peroxide of manganese and comminuted bone; and also *overlying* remains of the hyæna, which mark the old floors of the cave in one of its areas.

From the phenomena and facts observed in this cave, Mr. W. B. Dawkins, who examined it, inferred that man, in one of the early, if not in the earliest, stage of his existence, dwelt in this cave, as some of the most degraded of our race do at the present day in some countries; and that he manufactured his implements and weapons out of flint brought from the chalk downs of Wilts, from the least fragile chert of the greensand strata at Blackdown Hills, in Devonshire, and also arrow-heads out of the more easily worked bones of animals of that era. Although the men of this cave employed fire, and were acquainted with the use of the bow, yet with their puny weapons of flint and bone they were far worse armed than the wild beasts of that day with their sharp claws and strong teeth. But the very fact that man held his ground against them, shows that cunning and craft more than compensated for the defects in his defensive arms. Again, as he was preceded in his occupation of this cave by some kind of wild beast, as was proved by the underlying fragments of bone; so he was succeeded by another kind of beast, the hyæna, as proved by the overlying bones.

How favourite a resort of quadrupeds this cave must have been, is manifest from the quantity of animal remains extracted from it. In all, these consisted of one thousand bones, one thousand and fifteen teeth, and one hundred and fifty-six jaws belonging to the lion, wolf, fox, bear (of two species), badger, the cave-hyæna, ox, deer (six species), Irish elk, horse, and rhinoceros (of two species). Amidst this aggregate of diverse quadrupeds did man find his entrance, and fix his crude habitation. What was man then?—the lordly biped; but at that time how lowly, how mean, degraded, and animalized, how unlike the civilized, reading, reflecting man of to-day!

Of other caves the principal ones may be briefly alluded to. The Gower caves, in South Wales, yielded to Dr. Falconer human bones amongst those of the elephant, as the Paviland cave did to Dr. Buckland, and as the Spritsail Tor and the Mewslade fissure did to Colonel Wood, in addition to abundant flint knives and bone weapons, all evidently shaped by man. A very significant exploration was conducted by Dr.

Falconer and Mr. Everest, in the spring of 1858, in a cave at Brixham, Devon. All possible precautions for a faithful registration of discoveries were adopted, and it was soon announced that human industrial works had been discovered, mixed indiscriminately with bones of the rhinoceros, hyæna, and other extinct animals, in the undisturbed ochreous gravel and earth of the cave. Experienced geologists examined the cave and its whole products, and concluded without doubt that they had not been introduced by different natural agencies at wide intervals of time. The establishment of this fact is obviously of great importance in similar researches, for upon it nearly the entire value of cave evidences for human antiquity rests.

The Brixham cave may be regarded as in itself a complete geological case in point, since no preventible chance of inaccuracy was left unprovided for, and every fact was corroborated by careful examination. It is true that no human bones were discovered in it, yet many humanly-worked flint knives were found, chiefly in the lowest part of the bone earth, and a very perfect one was disinterred at a depth of thirteen feet from the surface, covered with bone-earth of the same thickness. Fifteen other flint knives were extracted in another part, which was at the same level as, though not in connection with, remains of mammalia. In the bone-earth also of this level an entire left hind-leg of a cave-bear was exhumed, with every bone in its natural place. It must, therefore, have been introduced to the cave when clothed with flesh, or, at least, while the separate bones were bound together by their natural ligaments, and buried in that state in the mud. Other interesting facts of a like character were noticed in the Brixham cave.

Dr. Falconer's researches in richly ossiferous caves in Sicily produced similar results, and it may be fully expected that other ossiferous caverns will, from time to time, add to the geological evidences of man's contemporaneity with several extinct mammalia. Even while we write we learn that another ossiferous cavern of interest has just been discovered in the rock of Gibraltar. There a human skull was found embedded in bone-earth, in close contiguity with a stone implement; and the bone of a large mammal twenty feet below the surface of a limestone plateau of very compact and solid rock. Seventeen feet below the level two human jaws were found, and close by it two stone knives, together with an oblong slab of sandstone, having one surface much worn and polished as if by friction. Many other interesting relics of human presence have been dug out from the same cavern, with fragments of pottery and bits of charcoal; all, however, tending to show that [illegible]ho once harboured in it were not of the most ar[illegible]

The preceding abstract of the most striking cave evidence has led eminent geologists to conclude, apparently with much reason, that man was contemporary with the mammoth, the cave-bear, the hyæna of dens, and several other extinct mammalia. To avoid this inference upon geological grounds is certainly not easy, nor can we fairly expect stronger evidences than the above, for these are both individually satisfactory to competent geologists and also cumulative. Other geological conclusions are admitted as established upon similar evidence.

So much has been said and published upon the famous flint implements of Picardy that it is unnecessary here to repeat details of their position and characteristics. The most cautious readers must be prepared to admit that equally cautious observers have at least very fair grounds for believing these flint weapons to be genuine as to antiquity, and unquestionably indicative of human handiwork. We ourselves have examined many of them, at home and abroad, and it would be sheer obstinacy to deny that they have been shaped by men. There are several minute characteristics by which genuine antiques can be distinguished from modern impositions; and no well-versed examiner can entertain doubts of the human markings in at least some hundreds of chipped flints extracted from the fluviatile gravels near Amiens and Abbeville. Dr. Falconer has recently shown to the writer two of the finest and most unquestionably worked flints from near Abbeville, which would carry conviction to the mind of any unprejudiced observer.

That a human jaw has been lately found, in association with shaped flints, in the gravel-pits at Moulin-Quignon, near Abbeville, must be known to nearly all readers, as well as the fact that it has been the subject of much discussion and minute examination with respect to its genuineness and antiquity. A joint French and English commission of naturalists and geologists carefully and locally investigated the whole matter. *Haches* (or flint hatchets) were disengaged from the cliff of the gravel-pit at Moulin-Quignon in the sight of these gentlemen, and they were convinced of the actual occurrence of the jaw in the "blackband;" but there was not the same unanimity about the age of the jaw itself. Dr. Falconer thought "the finding of the jaw authentic; but that the characters which it presents, taken in connection with the conditions under which it lay, are not consistent with the said jaw being of very great antiquity;" and Mr. Busk adds that "there is no longer reason to doubt that the jaw was found in the situation and under the conditions reported by Mr. Boucher de Perthes; nevertheless it appears (to Mr. Busk) that the internal condition of the bone is wholly irreconcilable with an antiquity equal to that assigned to the deposits in which it was found." Here, of course, Mr. Busk refers to the prevalent geological opinion that the gravels of Moulin-Quignon belong to the "high level" gravels of Mr. Prestwich, which are regarded as the oldest beds on the banks of the river Somme.

In the above condensation we have referred almost exclusively to what are at present the presumed oldest remains of man and his handiwork. Our limits forbid the introduction, at least in this article, of explanations of less remote evidences of human antiquity; and if we have proved the greater, we have inclusively proved the less. To those who desire a definite computation of something approaching to the number of centuries to which the remains cited point, we can only say that no such definite computation can be made, and geologists seem averse to commit themselves to any conjecture of actual time on this point. When Sir Charles Lyell states that if the Natchez man's remains are genuinely antique, they indicate an antiquity of at least one hundred thousand years for the first population of the valley of the Mississippi, he leaves the range of estimate for other relics open to any latitude or longitude which other geologists may choose to calculate. Yet it is manifest that, if the opinions of those who demand for man the longest antiquity be well founded, more than one hundred, or perhaps two hundred thousand years will be requisite, according to the Lyellian method of estimating geological time.

The public at large, and especially certain classes of persons to whom geological science is new and strange, naturally shrink from such conclusions. The question, however, must inevitably be tried upon its own appropriate evidences, and if these are adequate to conviction then preconceived chronology must give way. On the one hand we may not regard the comparatively immense antiquity of man as absolutely demonstrated; but on the other hand we must not ridicule and cast aspersions upon the opinions of men of high geological eminence, whose interest in the matter is not personal but simply scientific, and who have for some years devoted their best powers to the elucidation of the topic. With these gentlemen we are disposed to think that time will add considerably to the evidences for human antiquity, and we should not be at all surprised if within a few years it becomes generally admitted as a geological canon.

At the same time there are geologists who are not yet prepared to side with the antique party. Pre-eminent amongst these is that very practical French geologist M. Elie de Beaumont, who during the discussion on the Abbeville jaw, delivered his opinion that the gravel deposit of Moulin-Quignon does not belong to the Quaternary or Diluvian age at all, but to the *terrains meubles* of the actual or modern period, in which he would not be in the least surprised if human bones were found. For himself, however, he added that he did not believe in man's contemporaneity with the extinct elephants, rhinoceroses, and other mammalia of the Quaternary period. Neither also did Sir Charles Lyell at one time; but he and others have gradually become advocates of great human antiquity.

On the whole, the difficulties of disbelief appear to us to be greater than those of belief; and even if the amount of antiquity be reduced, so that from one geological epoch we are compelled to retreat into another and less remote, nevertheless even with the strictest circumscription and the sternest concision, we can scarcely be brought back to a duration of man at all corresponding with the popular chronology. Suppose, for example, that the age of the Picardy gravels overlying the shaped flints should be subsequently estimated at far less than their now presumed age, even then twenty thousand years or more would be, as geologists reckon, but an inadequate period for the accumulation of from sixteen to twenty feet of material in the common course of geological deposition.

If, however, we once transcend so greatly the popular chronology as to attribute to man an antiquity of even twenty or thirty thousand years, the Rubicon is passed, and may we not as well march boldly on from the other side, without remembering what the passage of the river cost us, or how long we hesitated upon its bank before we ventured to bathe our feet in the chilling waters?

NOTE.—At a meeting of the Geological Society on June 3rd, an interesting and animated discussion followed the reading of a paper drawn up by Mr. Prestwich on the Gravels of the Somme, in Picardy. Dr. Falconer explained the difficulty he had felt respecting the alleged human jaw from Moulin-Quignon, and rather recanted his published assent to the "authenticity of its finding." He was succeeded by Mr. Evans, who detailed the suspicious circumstances of the flint implements said to be found near it, and confirmed the doubts of Dr. Falconer both as to the flints and the jaw. Mr. Busk spoke respecting the jaw, and his minute examination of it. On the whole, there appeared much reason to conclude that the jaw was far more modern than the gravel, and that it may have been the jaw of a man of the historic period, perhaps of the Romano-Gallic times. The almost inevitable inference from the evidence stated by the above-named three gentlemen was, that the jaw was not a remnant of a primeval man, but of a man who lived in historic times.

ON THE PHYSICAL GEOGRAPHY OF THE IONIAN ISLANDS.

BY PROFESSOR D. T. ANSTED, M.A., F.R.S.

PART I.

THE group of islands adjacent and nearly parallel to the shores of Albania and Greece that are known as the Ionian islands, may be regarded as the summits of a nearly submerged mountain chain, parallel to the Pindus, and having a similar geological axis. The islands may well be regarded as a group, for they all exhibit nearly the same class of phenomena, and nearly in the same way. The principal rock is everywhere a peculiar limestone, very easily acted on by the weather. This limestone is seen partly in its normal state as a rock *in situ*, but more frequently broken into innumerable fragments. It is also presented as a conglomerate, or recomposed rock, made up of fragments, either angular or rolled by water, cemented by carbonate of lime, and mixed with many flints. With the limestones are marls locally abundant, and some marly sands, while gypsum occasionally takes the place of carbonate of lime. The islands afford a great variety of scenery, and are a perfect study to the artist, the geologist, and the physical geographer of all that is most interesting in lime rock. There are caverns in abundance, rocky cliffs, peculiar kettle-shaped valleys, mountain chains, ridges, plateaux, and rocky ravines. The alternations of softer rock and marl, though few and local, are not without importance as contrasting with the limestone.

Geologically, the axis consists of the Scaglia, or Apennine limestone, often loaded with flints, and nearly of the age of our chalk. It is sometimes made up of those peculiar fossils the Rudistæ, of which the Hippurite is a familiar genus. This is flanked by a great thickness of tertiary limestone, partly of the olden period, and containing fishes like those of Monte Bolca; partly more modern, and in many places consisting of a very modern conglomerate formed under water, but now lifted at a steep angle, parts of it being more than two thousand feet above the level of the Mediterranean. There is, besides this, a much newer sub-aerial conglomerate now forming, but already of great thickness in certain localities.

Although the islands are very similar in the details of their physical geography, it will not be possible to make the matter intelligible without referring to each separately. I will, however, avoid repetition as much as possible, and point out the most essential peculiarities in the island in which each seemed to me most striking. Thus, the peculiar kettle-shaped valleys are highly characteristic of Corfu, although in Santa Maura there are some of great interest. So the ridge-like character of the Scaglia is best seen in Cephalonia, where also exists the loftiest mountain-chain, and where the weathering struck me most forcibly. Santa Maura exhibits the phenomena of the conglomerate. Zante, the valleys, and some of the mineral contents of the rocks, especially the mineral pitch. Ithaca, the island of greatest classical interest, and one that is highly picturesque, is but one continuous ridge, secondary to Cephalonia. Cerigo is the island of caverns. Paxo and the smaller islands I shall hardly have space to allude to in this brief sketch.

Corfu is politically the most important of the islands, though not the largest or most peopled, Cephalonia exceeding it in both these respects. This political importance is derived partly from its position at the mouth of the Adriatic, partly from its harbour, and the sheltered channel between it and Albania, but chiefly from the fact that the town and harbour are defensible, a matter that can hardly be said of any other island in the group. Corfu is also the island first reached from the north.

Corfu is a long strip of land with a transverse mountain-chain. It is shaped like the capital letter **T**. The outline of the island is formed by high land along the western side, and also across the northern end, forming the top of the **T**. The eastern side is divided into two principal tracts of low ground by a picturesque chain that crosses it a few miles south of the town, and culminates in the mountain called Santi Deca, or the Ten Saints. The west coast of Corfu is fine, bold, and highly picturesque. Within the line of the hills and cliffs is the cultivable land, broken and very beautiful, and covered almost entirely with olive-trees, only varied occasionally by the tall black cypress which is very abundant in certain localities. The olive in Corfu and most of the islands being allowed to pursue its natural growth after a very early grafting, is a wonderfully more picturesque, though perhaps not so profitable a tree as when cultivated and kept down in Italy and Provence.

The mountain system of Corfu in the north stretches quite across the island, and rises into two principal peaks, the higher of which, San Salvador, is about 3,500 feet above the sea. Between these two is a tract of broken, but elevated table, land, and the ridge continues to the sea on both sides. It is on the south side of this chain that the enclosed valleys are seen that are so characteristic of the islands.

There is a very beautiful ride or drive from Corfu across the island to Pellcka, a cliff overlooking towards the west a lovely broken piece of wooded but little cultivated ground, not unlike some part of the Undercliff of the Isle of Wight. Looking east, the rich plains of Corfu are seen dotted here and there with small villages. To the north, however, the view is very different. Coming to the very edge of an inland cliff, one sees with astonishment a tract immediately below extending at a perfectly dead level for some miles, shut in towards the north by the mountain range of San Salvador, which rises with singular abruptness; shut in also on each side by other lower hills, but equally abrupt. Towards the west the hills are very narrow, merely serving to separate the valley from the sea. This remarkable valley is called the Val di Roppa. Entirely without natural drainage, it is the receptacle of a large quantity of rain falling on the mountain sides adjacent. All this rain runs down into the valley, carrying with it abundant stones and mud from the hill sides. These gradually accumulate, and have formed the flat bottom. The rain, retained for some months on this bottom, poisons the air of the whole neighbourhood, but is generally evaporated off in time to allow of crops being sown. During winter it is first a lake, and then a swamp, and is a favourite place for shooting waterfowl. During spring it is cultivated. During summer it is the source of malaria, and helps, no doubt, to render the air of Corfu so insalubrious, that the population for many years past has been almost stationary, and the miserable villages surrounding the valley are kept constantly at the lowest point; the men and women dying young, and the children being seldom reared.

This valley is only one of several. Immediately adjacent is another of the same kind. Not far off is another perfectly round, where the water remains so long on the ground that there is no cultivation. South of Santi Deca, in the other part of the island, there is one known as the lake of Corissia, shut in in a nearly similar manner, and almost as large as the Val di Roppa. In Santa Maura I have seen them exactly resembling a vast artificial amphitheatre. In Cephalonia they are deep lakes. Wherever they are seen they are of a similar nature. They are great hollows with limestone bottoms, surrounded by limestone rocks. From the rate at which the
isappears through the bottom, it is certain that they have
ion with some natural drainage, only checked by
at the surface by what the rain brings

down from the hills. They are in fact valleys produced by the sinking in of the strata into some great natural cavern formed or enlarged by the infiltration of the rain-water. They vary much in size, but none are too large to be thus explained.

As might be expected, caverns abound in districts so calcareous, and many of them have been described. They offer nothing remarkable, except indeed that in the island of Cerigo, which does not belong naturally to the Ionian group, the limestone fragments have formed a breccia with bones of extinct animals; but all of them illustrate the state of the rock. There is, however, a still more curious illustration of this in Cephalonia, close to the town of Argostoli. A large and broad gulf enters from the south to the western part of Cephalonia, and from this a small transverse bay opens to the east. A spit of comparatively low ground with hills behind marks the junction of these two bays. Part of the land here appears to have sunk in, and the naked limestone rock, much broken, forms a kind of reef, keeping the sea from the narrow low tract of sunken ground. At three or four places the reef is broken, and the sea enters narrow irregular fractures, and is swallowed up in the earth. Advantage has been taken of this curious inversion of the usual order of things, and two mills are worked by the power of the entering stream of salt water made to turn an undershot wheel. The mills worked by the rush of sea-water losing itself in the earth have long been a subject of great astonishment both to the inhabitants and to the few strangers who visit Argostoli. Certainly, that there should thus be a permanent rush of water into cavities in the rocks close to the sea, and considerably below the sea-level, and that this should go on permanently, or for an indefinite period, without filling the cavern, is an extraordinary phenomenon, and requires explanation. No doubt, the generally broken and cavernous state of the limestone, in all directions, suggests a clue to the mystery; but the full explanation is to be found in the climate, which is such that, during a great part of the year, the surface is always burnt up, so that the evaporation must exceed the natural supply from rain if any means exists of supplying the deficiency. The rock being split, and full of capillary fissures as well as more open cracks, there will always be evaporation from the pools or moist rock at whatever depth, so long as the surface is dry and heated. Thus, the water entering the broken rock finds its level in some subterranean caverns where the surface always remains below that of the sea, because more water is carried off by evaporation than is received from the sea and the rains together. The perfect dryness of the surface, combined with the presence of malaria in the Val di Roppa, and many others of the kettle-shaped valleys, are further illustrations of the work of nature in this respect.

The weathering of the limestones in the Ionian Islands affords some of the most interesting and remarkable examples of sub-aërial action that can anywhere be seen. It is worth travelling to Greece to see what can be done in this way. From time immemorial Greece and the Greek islands have been remarkable for their troublesome barking dogs, and also for the means nature provides for ridding oneself of the annoyance. Homer tells us that when poor Ulysses, disguised by Minerva, visited his old swineherd Eumæus at the Rock of Corax, in Ithaca, he landed, and had no sooner approached the enclosure than he was attacked by his own dogs. So accustomed, however, are the dogs to be driven off by throwing at them the innumerable loose stones ever at hand, that one has only to stoop to ensure their running away. The history of these stones is not a little interesting, for they are the examples, proofs, and indications of destruction caused by the air and the weather.

The loose stones are so predominant that it is not often one has an opportunity of seeing the actual solid rock beneath; and in a majority of cases, when compact rock is seen, it is a reconstructed mass or breccia of stones, either rounded or angular, which for some local reason has formed a capping and checked the atmospheric action. It is interesting to trace the history of destruction. Selecting a particular stone of large size, we shall find it pierced by numerous holes of various depth. Some run quite through, a passage having been bored whose size varies from an inch to a foot in diameter. In these the boring implement is no longer visible. Others are bored to a depth of a few inches, a foot, or even a yard. In the smaller bores are single plants, small or large, according to circumstances; in the larger ones, a complete garden and a quantity of vegetable soil. I have seen at least a dozen kinds of wild plants at the bottom of one wide and deep hole. Nor are these holes all vertically downward. They slope at considerable angles. Some of them are so placed that they can hardly allow the rain to enter. Some are irregular; some are imperfect; but the connection of vegetation with the holes bored in the stone is quite unmistakeable. I have often seen and studied weathering in rocks of various degrees of hardness, but I know of no such examples of rapid and complete weathering. Riddled by these holes, which cross each other in various directions, the large detached rocks are rapidly converted into smaller ones, and these again into mere stones. [illegible]nately, no doubt, the stones are rolled and ground down [illegible]nd sand, or are carried into the valleys; but as fast as one broken surface is cleared off another is ready, preserving the same general appearance, though with materials constantly changing.

It was an interesting point to discover, if possible, the time required for this destruction in any particular case, and though not easy in a single observation, there are means at hand in these islands which help greatly an estimate. Such are the ancient walls of cities celebrated in history, but of which absolutely nothing now remains but vast blocks of stone piled in regular order, and originally serving as a defence against the most approved mode of attack in their day. The latest period of the most complete work of this kind is more than two thousand years ago. No doubt at that time the walls of the ancient Samos in Cephalonia, attacked by the Romans and resisting for four months the most strenuous attacks of M. Fulvius, were in good condition; and therefore, in looking at their present state, we see the work of twenty centuries, or thereabouts, of weathering. Of the buildings enclosed within the walls, some may have been built, and all, no doubt, were covered in with tiles; for the whole soil is so mixed up with fragments of burnt clay, that the stones, however abundant, are hardly noticed. The ground is literally covered with pale red fragments of burnt clay, and as brick is less liable to injury than limestone from weathering, there is good reason for this. But although a place where stone is so infinitely abundant, and in a country whose inhabitants were certainly familiar enough with the mode of working it, so that there was every possible reason for stone having been used for all kinds of constructive purposes, hardly one fragment of stone-work has been discovered either on the surface or buried, except the walls themselves. And there is but one explanation—everything else has been worn to powder by weathering. In the ruins below, where the Romans established themselves and remained for a long time, it is curious to see how well their work has been kept when consisting of bricks and mortar, or even terra-cotta of the commonest kind; but there also, except a fragment or two of statuary sheltered amongst the ruins, there are no worked stones.

The reason why the walls still remain, in spite of the absolute annihilation of every other sculptured stone, one has not far to seek. The whole design and construction of these walls is on a scale so gigantic as to have fairly resisted the efforts of decay in many parts, while in others it has partially yielded; and it is this partial destruction which renders the whole in some measure a scale by which to estimate the rate of decay. The walls are of the kind called Cyclopean—composed of hewn stones of size so gigantic that no one in modern times has given a satisfactory account of the mechanical means by which they could have been lifted into their places. Like those curious Druidical monuments in Western Europe and on our own island, they contain a mystery. The construction shows three stages of rough art. The earliest involves only the selection of large blocks, whose surface was dressed, but of which the natural shape was not altered. Marvellous ingenuity was shown in so selecting and placing these stones that the salient angles of one should fit the retiring angles of others, so that a solid and compact wall should be formed without mortar. The blocks of this work vary from one to five tons in weight. The second stage involved the use of larger stones cut to regular shapes, but not with right angles. The stones are polygons, perfectly worked and accurately fitted. Some of the larger stones must weigh ten tons, and there are few smaller than two tons, even to fill up gaps. Lastly, the stones are found regularly squared, like those still used, but of dimensions utterly beyond comparison. Single stones, sixteen feet long, four or five feet high, and three or four wide, are not unknown. Large stones have been raised to a height of ten or twelve feet; and the walls themselves that surrounded the town of Samos in Cephalonia, when it was attacked by the Romans, were not less than twenty-five feet in height. It is clear that the oldest work had failed from time to time, and had been replaced here and there by new work in the style of the day; and thus the same wall will contain portions of each style down to the Roman occupation. It is certain that from the time of the Romans to the present day there have not been inhabitants in the Ionian Islands to perform the utterly useless task of removing these heavy stones for any useful or mischievous purpose. No town or even village has been built near, except a few houses in the present century. Any injury the walls have suffered must be by the hand of time. When, therefore, we see them partially standing, partly fallen—when we find the ground on each side of the walls blocked up with fragments, shapeless and weather-worn, with trunks of trees grown into and enlarging the intervals between two stones, and thus dislodging the upper ones—we may be sure that nature alone has operated. The result is that of the whole length of a great wall, originally not less than twelve feet wide and upwards of twenty feet high, there now remain only the lower stones. These are much interrupted by large gaps; the stones that are still in their place are almost without exception pierced through and through with large holes, in which, when incomplete, plants will invariably be found. The stones most recently overthrown are now being broken up into small fragments by similar action, and in many cases the very rock itself on which the stones were placed, as on a firm foundation, is lower by several feet at a little distance from the walls, these having sheltered the foundations while the work went on rapidly on the stones above. It is only in a few places that the height of the ancient wall is indicated. Not in a single instance did I see a good specimen either of Cyclopean, polygonal, or the more finished Hellenic work detached from the wall by accident and at all recognizable. On the other hand, where, as in Santa Maura, the walls have been taken down, and the stones removed for any purpose, the weathering has not affected them beyond what is due to the time they have been exposed. Every stone that had been removed, or fallen by the progress of decay, had been entirely broken up.

Weathering on so grand a scale, and limited in this way to a period of time absolutely definite, is very rarely to be seen, and I have thought it worth while to dwell at some detail on the facts and inferences. It is one of the most interesting points in the physical geography of the Ionian Islands, and one of the most instructive examples of a great natural operation everywhere going on, that has ever fallen under my observation.

There are not wanting peculiarities of climate and other local causes that help to account for these phenomena. The nature of the limestone itself is also very favourable, the rock being in that semi-crystalline state indicative of considerable purity, and peculiarly liable to an infinite multitude of minute crevices opening a way for and even inviting the action of water. The water that falls from the air in the shape of rain is always able to effect a lodgment in such rock; vegetable matter of one kind or other soon attaches itself, and the decay of this earliest vegetation is sure to contain the material for converting the oxidized water from the clouds into an acid solution acting rapidly on the stone. Thus each successive stage facilitates and hastens the operation. The climate being insular ensures a certain supply of rain at intervals through the year, and no doubt helps to advance the work. When there is room for the intrusion of the roots of a larger kind of vegetation than that which penetrates the surface, it is extraordinary to see how the natural expansion during growth is capable of lifting out of their places even the heaviest stones, and even occasionally building such stones into the very trunk of the tree. I have noticed this especially with regard to olive-trees in Santa Maura.

THE TELESCOPE.

BY JAMES BREEN, F.R.A.S.

THE lines of Wordsworth in which he seeks for the cause of his disappointment in looking through a telescope—a disappointment very frequently expressed by those who look through "optic glass" for the first time—are well known :—

> Yet, showman, where can lie the cause ? Shall thy instrument have blame—
> A boaster that, when he is tried, fails and is put to shame ?
> Or is it good as others are, and be their eyes in fault—
> Their eyes or minds ; or, finally, is this resplendent vault ?
>
> Or is it rather that conceit rapacious is and strong,
> And bounty never yields so much but it seems to do her wrong ;
> Or is it that when human souls a journey long have had
> And are returned into themselves, they cannot but be sad ?

The bard of Rydal was, however, but an indifferent judge of what should be expected from a telescope. On a subsequent occasion, whilst gazing through one of the finest and largest instruments in the kingdom, the appearance which most attracted the "poet's eye" was that presented by a star or planet with the eye-piece out of focus, when with its coloured fringes and prismatic rings it assumed, as the poet himself expressed it, that "beautiful bird-of-paradise aspect" which is not at all popular with opticians, who much prefer distinct and colourless images.

It must, however, be confessed that many are disappointed with the telescopic appearance of the brightest single *stars*, which appear smaller the more perfect the instrument. It is different indeed with the larger planets, the sun, but above all the moon, which latter, with its vast and rocky mountains, particularly during its first and last quarters, is always a glorious object. In a large instrument, too, the sight presented by the resolution of one of the globular clusters, where thousands of stars are huddled into a space apparently but a few inches in diameter, is wonderful in the extreme. Perhaps, however, in all of these the amateur bserver is more or less disappointed, when he hears that he looking at those glorious orbs with powers magnifying from d to a thousand times,—not considering how far they are removed from view even when the distance of these remote objects is diminished by that amount.

When the telescope (whether that discovered by the Tuscan artist or German optician) first revealed the glories of the heavens, it was imagined that by the simple combination of an eye-lens and a single object-lens, the problem was completely solved, and that the principle at least could not be improved. It was seen indeed that it gave indistinct and coloured images, and these latter for a long course of years baffled every endeavour to correct them, and it was not until a century and a half after the invention of the telescope that they were finally removed, and that objects seen through this instrument appeared perfectly colourless and well defined. The causes of the imperfection of the original telescope were that the rays of light could not be made to meet at the same focus, and this was also the case with the colours of which the original ray of white light is composed, and which was decomposed, as by a prism, into its original parts by its passage through the lens. These are technically called *aberrations* or deviations—the first, resulting from the figure of the object-lens, is termed the *spherical;* the latter, which depends on the glass itself (all homogeneous transparent media being affected by this cause), is called the *chromatic* aberration.

The spherical aberration arises from the circumstance that of the parallel rays passing through the lens A B (fig. 1), those near the margins of the glass will be bent or refracted to the focus f, whilst those passing nearer the centre of the lens will arrive at their focus at the point f'. The distance between those points is termed the longitudinal spherical aberration. If we look at the image of the sun thrown through a convex glass upon a dark screen, it will be noticed that instead of a point of light, the so-called focus will be surrounded by a halo. But if the outer margins of the lens be hidden by an annular diaphragm, it will be seen that less haziness exists and the focus becomes more distinct at the point f'. By giving certain curvatures to the lens the spherical aberration may be greatly diminished, although not altogether got rid of by using a *single* lens, at least by one having *spherical* surfaces. For instance, in a plano-convex lens with the plane side turned towards the parallel rays, the distance $f f'$ is four and a half

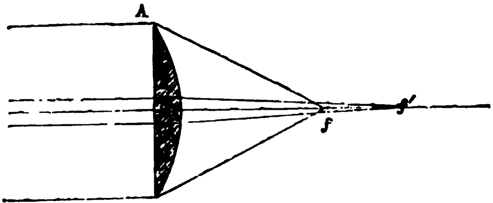

Fig. 1.

times the thickness of the lens at the centre. The smallest aberration takes place when the lens used is a double convex one, the radii of the spherical surfaces being as one to six, and the more convex surface being exposed to the parallel rays, in which case the distance ff' amounts to one and one-fourteenth of the thickness of the lens. The spherical aberration can likewise be corrected by making use of elliptical and other curves instead of spherical, but the latter from their simplicity are now always preferred.

The greatest objection to the use of the refracting telescope with one lens was, however, the fringe of extraneous colour which surrounded all the objects. In a homogeneous convex lens of glass the violet rays are bent much more than the red, so that the focus of the former V (fig. 2) is situated nearer to the object-glass than the latter R, and the other coloured rays have their foci between those two points.

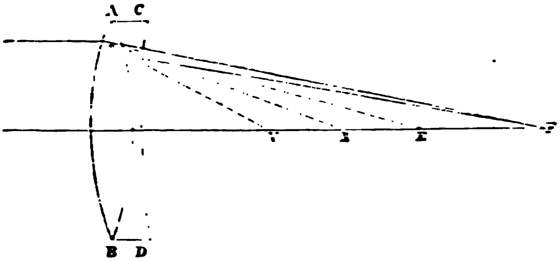

Fig. 2.

It has been calculated that in a lens with a focus of twenty-seven feet, the distance between the foci of those two points amounts to one foot. The confusion of the coloured images resulted, and which even Newton regarded it hopeless to think of correcting, was at length got rid of by Dollond (though it had previously been found out by Hall), and is considered to be the greatest optical discovery of the eighteenth century. By making use of prisms of different liquid or solid transparent substances, it was found that the separation of the ray of white light into a coloured ribbon was not always of the same length, nor had it the same position in respect to the incident ray. From this Dollond hit upon the happy idea that it might be possible, by combining two transparent media of different *dispersive* powers (as these changes were called), to bend a ray of white light out of its original path without separating it into coloured rays. He found that by placing a prism of crown-glass with an angle of thirty degrees in front of another of flint-glass with an angle of nineteen degrees (the angles being opposed), that this result was completely attained; and as a lens may be considered as a series of prisms, it followed that if a convex lens of crown-glass A B, (fig. 2) were placed in front of a concave lens of flint-glass C D (with focus at E) formed to the correct curves, a colourless focus might be thus obtained. The result was the achromatic telescope. The aim of the optician was henceforward, therefore, to adopt the truest curves in which to grind and polish his glass, and to seek to unite the violet and red rays at the true focus F. Should the violet ray still be behind the red one, the telescope is *under-corrected;* but should the flint-glass, on the contrary, err on the opposite side, the violet ray will have a focus beyond the red one and the convex glass be *over-corrected.* The discovery of Dollond, it may be imagined, created great interest at home and abroad, and was a great boon to astronomy, as the celestial bodies could now be seen equally as well, if not better, with telescopes of four or five feet in length than they formerly had been with tubes of ten times those dimensions. For upwards of half a century the English achromatic held the monopoly of the market, and it is even said, led to a profitable smuggling business; and yet we believe that before the year 1828 an object-glass exceeding six inches in diameter had not been executed in this country.

The great difficulty lay in obtaining discs of glass proper for the purpose. It had not only to be pure, but beyond suspicion, and so many tests could be applied to examine its quality that very few specimens escaped without the detection of some flaw. If a skilful optician, following the advice of Mrs. Glasse, could first catch that material, the subsequent operations would give him far greater pleasure than toil, although immense labour and patience are required in grinding it in an iron basin and polishing it with mysterious powders and secret contrivances, of which each professor of the optic art has his own. The first discs of any size were those constructed by Guinand, who by his own unaided exertions produced specimens eight inches in diameter before the close of the last century, and subsequently, in conjunction with the greater genius of Fraunhofer, produced that miracle of skill—the Dorpat telescope of ten inches aperture. The successors of Fraunhofer have surpassed him in glasses ranging up to sixteen inches in diameter, which for definition and absence of colour are equal to the Dorpat, whilst exceeding it enormously in light-giving powers. What progress has been made by our own opticians might be seen at the last Exhibition. Various specimens of excellent and large foreign telescopes are to be met with in this country; indeed, the three largest of Cauchoix, of a foot in diameter and upwards, are in Cambridge, London, and Sligo.

It is not every one, however, who has an opportunity of possessing, or of looking through a telescope of these great dimensions. Nevertheless, much can be done with an instrument of even moderate size. Messier discovered some score of comets, and upwards of a hundred nebulæ and clusters, with a five-feet telescope. The great map of the moon—the standard one by Baer and Maedler—was delineated by an instrument of scarcely greater power. M. Goldschmidt has detected upwards of a dozen of planets with instruments ranging from a common opera-glass to telescopes of about four inches in aperture; but in this case a most extraordinary keenness of sight must aid the unwearied diligence and patience of the observer. Although Maedler states that only two hundred nebulæ can be detected with a telescope of five inches aperture, yet D'Arrest assures us that he can see that number with a common hand-telescope or comet-seeker, whilst with an instrument of four inches aperture upwards of a thousand are visible. A great deal, in such cases, depends upon practice: but a few precautions being taken, the amateur will, in a short time, be encouraged to proceed, by looking at the same objects at different times. Probably, he may notice that some stars which were pointed out to him as double, appear only as hazy and ill-defined single ones on one evening, whilst a few nights afterwards, with the sky apparently no clearer, they may be transformed by some magic process into what he had been originally apprized of. The state of the atmosphere exerts a wonderful influence on the definition of objects. Herschel, we believe, only allowed a hundred hours of superfine observing weather during the year. Secchi (at Rome) confesses he is more fortunate, and owns that under the cerulean sky of Italy he is favoured with a clear fifteen nights throughout the year. And yet these two observers have been constantly on the watch for these happy moments, not one of which, the latter tells us, should be lost, but the telescope at once directed to the faintest and minutest objects. We have ourselves found, that the best definition and brightness exists when the wind is from the damp southerly and westerly quarters, and the worst when from the dry north and east, particularly the latter. It is important to avoid placing the telescope at a window, especially when the atmosphere within is of a higher temperature than without; and Herschel goes so far as to say that no roof with an opening, or even shady places in the open air, should be allowed. The same authority tells us that sudden changes from frost to thaw, or vice versâ, are bad for definition. Above all, good definition need not be expected near the horizon, where undulations, mists, [illegible] ations give a boiling motion at the best of tir[illegible] vation impossible. It is necessary, al[illegible] th the object-glasses and eye-pieces scrupulously clean; for this purpose a piece of old lawn is much preferable to silk, and some say a well-crumpled piece of tissue-paper to either. When the instrument comes from a good maker, the centering of the object-glass and its proper position in its cell has doubtless been duly taken care of, and should not be disturbed. Sometimes, however, the glasses of both the object- and eye-lenses are pinched too tightly, which distorts the images fearfully; a little unscrewing will at once set this to rights.

The ordinary achromatic refractor is composed of simply the object- and eye-lens, without any intermediate glass. This latter, however, like the former, consists generally of two separate lenses, although both are of the same sort of glass. The negative eye-piece consists of two plano-convex lenses, the plane sides being turned towards the object-glass, and when made of crown glass, separated by a distance equal to half the sum of their focal lengths. When measuring apparatus is attached to the telescope, an eye-piece is employed, formed of two plano-convex lenses of equal focus, separated by a distance equal to two-thirds of the focal length of one or other and their convexities opposed in the tube. This is called Ramsden's eye-piece, and gives a flat field of view, with the advantage already mentioned that a system of spider lines, or cross wires, can be distinctly seen at the same time as the double star, or planet, whose distance or diameter is to be measured. Both of those are inverting, but this is of small account in looking at the heavenly bodies. The erecting eye-piece, consisting of four lenses, although admirably adapted for land use, is never made use of for the latter purpose, as each lens tends to obstruct the light which is so precious when gathered to a focus. It need scarcely be added that the eye-piece must be adjusted with the greatest possible nicety for different sights. This is easily done by the rack and pinion motion after a few trials, whether upon the edge of a planet or by judging of the appearance of a double star, or by the visibility of the faintest single stars in the field of view.

With an instrument of three to four inches aperture (and a good one of the latter size will bear a magnifying power of from 300 to 350) the belts and markings on Jupiter, the snows of Mars, the ring of Saturn, may be well seen; and the spots and faculæ of the sun, and all the gorgeous phenomena of the moon, rendered most perfectly. The nebula of Orion surrounding the trapezium will likewise amply repay curiosity on clear dark nights. Some hundreds of double stars—shining in all their different lustres, colours, and distances—are a constant source of pleasure. In addition to these, many clusters and nebulæ may be seen with such an instrument.

Mr. Dawes has been able to separate some exceedingly close double stars, and observe some very faint ones with such a telescope. The amateur will soon get accustomed to the difficulty of the various objects, and know what powers to apply, according to the fineness of the night or other circumstances. Admiral Smyth—one of the most successful observers of the age—advises the amateur not to be afraid of his small instrumental means, but to look at everything; and it is certain that with some costly apparatus much less is seen than with less pretentious affairs.

For small instruments, the ordinary tripod stand, with slow motion in altitude and azimuth, is as convenient as any, where merely viewing the object is all that is required. For larger ones, where measurements of the positions and distances of double stars are to be obtained, the telescope is mounted equatorially—the support of the instrument, instead of being pointed to the zenith, being placed parallel with the axis of the earth—by which means, by merely shifting the telescope to the right, the star is always in the field of view without any vertical motion. To most large instruments strong clockwork is attached, by which this motion to the west is duly regulated, and the observer has only to keep his eye to the telescope, which of itself follows the star. Although in the last century and the time of Sir W. Herschel reflectors of from six to ten feet were greatly in use, yet of late years, in the case of small telescopes, it has been almost completely superseded by the refractor, and on that account we have confined our observations to this most convenient description of optic tube. Unless extreme care is used with a reflector, the metal mirror is very liable to become tarnished, whilst dew or dust settling on a glass lens can easily be wiped off with a soft cloth. In France, however, small reflectors are again coming into vogue, the mirror being formed of glass and coated with a thin film of silver; and as the latter has a reflective power of 91 to 67, in comparison with speculum metal, it has a great advantage in this respect; but, unfortunately, tarnishes very readily. As, however, the silver film is easily renewed, this is of the less consequence. We had the pleasure of inspecting several instruments of this description by the celebrated M. Foucault, at Secretan's establishment at Paris, some time since, which were beautifully fitted up. A reflector of about forty inches aperture has since been made by those gentlemen, and as it was with one of those glass mirrors that the companion of Sirius has been detected, it may give an idea of their merit.

The largest refracting achromatic telescope we have seen, we believe to be at present the largest in the world, is that made by M. Porro, and which still remains at Paris. The object-glass is 54 centimetres in diameter (21·26 inches) and has the immense focal length of 15 metres, or nearly 50 feet. It is mounted with an azimuth and altitude motion, and at first sight looks like a gigantic fire-escape. The tube is composed of three hundred pieces of wood joined together by three thousand screws. Great controversy has arisen respecting the merits of this instrument; but M. Bulard, the astronomer at Algiers, asserts that he could see everything with it that he had with Earl Rosse's 6 feet mirror; and M. Porro states that he has detected two new stars within the trapezium of Orion. It is certain, however, that although in existence for six or eight years, it has been very little used. Comparing this immense instrument with the modest five-feet telescope of M. Goldschmidt, erected on a moveable tripod stand in his garden near Paris, and with which he has discovered so many planets and variable stars and nebulæ, and made so many curious observations, it will be seen what may be done with care and patience even with small means.

Should the observer be provided with a telescope mounted equatorially, he has simply to set the declination and hour circles to the object required, and of which he has of course the right ascension and polar distance given. In other cases, in searching for any particular object, he must make use of an ordinary star-map divided in the usual manner into right ascensions and declinations, on which having marked the position of the required nebula, comet, or double star, he guides the direction of the telescope by means of the bright neighbouring stars of the constellation in which the object is placed; and with a little management this operation will soon become easy. In the same way, to find any particular planet, its place on the required day will be taken from the "Nautical Almanac," or any similar work. Great assistance in the choice of stellar objects will be derived from Admiral Smyth's "Celestial Cycle," in which the most prominent clusters, nebulæ, double and variable stars are fully described, and full particulars given of their positions, brightness, and difficulty. In pointing the telescope, the observer makes use of the small side tube, termed the *finder*, which, giving a large field of view, helps him in the *alignement* of the faintest stars marked on the map. In searching for comets, the lowest power of the telescope should be made use of; and if a nebulous object be caught sight of, its place should be transferred to the map, in order to determine whether any fixed body of that character has been before observed. In all cases it is almost useless to search for objects with high powers, which not only gives a small field but renders them very faint. It will be found that the eye will distinguish faint objects much more readily by keeping it in the dark a few minutes previously. The observer will remark some anomalies in different eyesight; some which can distinguish very faint objects are unable to separate a close double star, and vice versa, and in many instances the colours of double stars will be judged differently. We need not state that a comparatively small telescope, in which the glass is pure and the figure polished to the true curves, will be found far more useful and pleasant to handle than a much larger one in which these conditions are forgotten. The excellence of the object-glass is the principal affair, and no beauty of mounting will compensate for this want.

In observing double stars, those which are well separated should be scrutinized at the commencement and the distances and magnitudes gradually diminished, until the most delicate objects which the instrument can bear are arrived at, and for which a very clear and favourable sky will of course be necessary. The observations of the double and multiple stars are the finest test for the performance of a telescope. Thus, commencing at the coarse double Delta and Kappa Herculis or Eta Lyræ, he may ascend to Theta Serpentis and Alpha Can. Venat. From Zeta Ursæ Majoris and Beta Cephei he can pass to Gamma Delphini and Eta Cassiopeiæ. Closer still are Alpha Herculis, Kappa Cephei, and Mu Cygni. Coming to those which are test objects for small instruments we have Gamma Virginis, Mu Draconis, Rho Herculis, Zeta Aquarii, &c., whilst on very favourable nights the observer may look for Delta Cygni, Pi Aquilæ, Xi Ursæ Majoris, Sigma Coronæ Borealis. All these stars are visible at the present time of the year, and their places marked on a good celestial globe. The amateur observer has only to transfer those positions mentally to the real heavens, which, with a little practice, will be as simple as finding any geographical position on a terrestrial globe by knowing its longitude and latitude.

CONTRIBUTIONS TO THE HISTORY OF THE ROTIFERA, OR WHEEL-ANIMALCULES.

BY PHILIP HENRY GOSSE, F.R.S.

PART IV.

THE FLEXIBLE CREEPERS (NOTOMMATINA).

UNINITIATED persons are sometimes startled, and not a little stumbled, by reading in books of scientific natural history such statements as this: "*A*—— *b*—— is a much more perfect form than *C*—— *d*——." They pause and ask whether there can be any degrees of perfection in the handiwork of the All-wise and Almighty God. Are not all His works perfect? The answer must be that they are; understanding the term to express the adaptation of the creature, and of all parts of its organization, to the purposes for which they were designed.

The naturalist, however, does not mean this. He is not speaking of the organism as an individual, with reference to its own objects and requirements; but as one of a series, with reference to an ideal standard of aggregate qualities presented by that series. Thus, when we consider Birds, we have before us a vast assemblage of creatures, the most prominent and characteristic feature of which is that they are constituted for flight, by means of a peculiar development and arrangement of tegumentary organs (feathers), associated with peculiar developments and arrangements of the skeleton, muscles, and breathing organs. Thus, then, we acquire a definite idea of a bird, notwithstanding that this idea is presented under considerable diversity in all these details, when we examine the thousands of species that are known; nor does this diversity at all interfere with the unity of the model or pattern which is involved in the aggregate idea of a bird. The comparison of these details, however, soon shows us that the characteristic features of a bird are much more prominent in some species than in others. In the humming-bird, the frigate-bird, or the swift—in the great breast-bone, the enormous lungs and chains of air-cells, the hard, dense, thick pectoral muscles, the firm rigid feathers, drawn out to long points on the wings and tail,—we see a high concentration of all the characters of a bird, as I have enumerated them above. Compare now with these the Guinea-fowl, with its short hollow wings, and small, weak, excavated breastbone; the tame duck, with its soft feathers and short, powerless tail; or the penguin, or the ostrich, in which the wings are reduced to mere rudiments, and have absolutely ceased to be flying organs; and you will see what the ornithologist means when he speaks of the comparative perfection of these birds, when he says that the humming-bird is the most perfect representative of birds, the penguin the least. It is not that the penguin is not most admirably fitted for its mode of life and its requirements;—nay, it exhibits some adaptations of structure to function which surprise us by their wondrous fitness. *As a creature* it is perfect, but not *as a bird;* there is a manifest departure from the characteristic structure and functions of a bird, and an approach to those of some other great model of animate existence, while it still remains essentially a bird. It is, perhaps, the least perfect of birds.

It is the same in the subordinate divisions. The swallows, taken as a family, are very perfect representatives of their class in the points above-mentioned; but there are degrees of perfection among them. The swifts possess the characters which mark the family in a higher degree than the swallows; while of these latter, how much more completely, "more perfectly," a swallow, is the chimney-swallow than the sand-martin.

Naturalists have been accustomed to use the technical term "type," or its adjective "typical," to express the greatest aggregation of characteristic features in any given group. Among birds, the perchers constitute the typical order; in this order the cone-billed birds take the typical place as a tribe; the finches, again, are the typical family of these; and what is the type of these pretty little birds, as I am not writing an essay on ornithology, I shall leave to my readers' acumen to determine.

There must always be some latitude in the determination of what constitute the typical characters of any given group, and therefore of the types themselves. One naturalist may picture to himself a different standard of completeness from that which another of equal eminence would assume; and hence no one ought to speak oracularly; he merely gives his judgment. The great group of tiny creatures of which m about to treat is, according to my judgment, the typical r of the class ROTIFERA. They may be designated, in parlance, The Flexible Creepers; systematically,—

the order *Notommatina*.* One mark of a typical group, almost constant, is that it contains a larger number of subdivisions than any other group of like rank; and populousness is highly characteristic of the *Notommatina*.

All these animals are permanently free, never becoming fixed to other objects, and never forming mutually adherent groups. Their bodies are not inclosed in a tube; and their skin is for the most part flexible, not forming a shelly mail, though in one or two genera certain portions of the integument are stiffened, indicating an approach to the structure of the mailed families. The form is generally cylindrical, with a length about twice the diameter on the average, occasionally, however, three or four times the diameter. The front does not expand into a flower-like disk, but is usually no wider than the body, very varying in its shape, sometimes being flattish, oftener convex, with many swellings, beset with strong vibrating cilia, which are so arranged as that their combined action produces two vortices, one on each side of the head. The opposite extremity of the body terminates in a thick foot of several joints, of which the last bears two diverging toes. These are used by the animal for its support, to aid it in crawling. They are in general moderately short, but in a few cases are of great length.

The characteristic appearance of the little animals of this order will be seen by reference to Plate XIX., in which figure *a* represents a dorsal view of *Eosphora aurita*, in the act of swimming. This is an elegant and sprightly species; especially beautiful when, as is very frequently the case, the enormous stomach and intestinal canal are filled with translucent green food. I have repeatedly met with it around London; as in a green pond in Greenwich Park, and in the tiny sweltering pools on Hampstead Heath, renowned, for more than a century, as being prolific nurseries of the higher forms of ROTIFERA. They will live and increase their race in a phial of water containing a little growing vegetation, as a sprig of water-moss, a few leaves of duckweed, or a small tangle of converva: the phial being left uncorked, and set in the light, but protected from the direct rays of the sun. Here they will play and rout about, delving in the sediment that accumulates on the phial's side for food; now and then shooting off into the water, and swimming evenly and gracefully along, slowly rotating on their long axis as they go. Their movements can be watched, and their forms distinctly made out, with the aid of a good pocket-lens, as the phial stands on the window-sill; and this sort of observation, which is highly interesting, can be pursued with great ease and satisfaction, especially if the finger of the disengaged hand be passed behind the phial (without shaking it), so as to intercept those rays of light which pass direct from the sky through the animalcule to the eye of the observer. The effect of this manœuvre is to make a dark back-ground for the object, while it is yet brilliantly illumined by the rays that fall on it from all around the finger. Small as is the magnification, the experienced observer has no difficulty in distinguishing the principal organs, which, under this mode of illumination, have a relief and a solidity which are very instructive.

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* This order is nearly concurrent with the family *Hydatinæa* of Ehrenberg. But the genus *Hydatina*, which he considered typical, and whose name he used for the family appellation, consists of only a single species, and cannot be separated from the great genus *Notommata*, except by the very trivial and valueless character of wanting an eye; or rather, of wanting the speck of coloured pigment which ordinarily accompanies the eye. *H. senta* is a true *Notommata*.

But I must describe our little beauty in detail. Its body is nearly a cylinder, of about a hundredth of an inch in length, with a diameter of one-third the length. Sometimes it becomes almost pear-shaped, by the swelling out of the hinder half of the body, when an egg is maturing in the ovary. In the Rotifera generally, the eggs are of immense size in proportion to the body; and in this species they are even larger than usual, an egg just ready for discharge occupying nearly one-fourth of the entire volume of the animal. In the figure such an egg is seen occupying a large space just behind the middle of the animal.

The head is capable of considerable alteration in shape. When the animal is busy feeding, resting on its two-toed foot, with the body thrown forward horizontally, the front of the head is so oblique that, by a little bending downward, producing some strong foldings of the skin of the breast, it can be brought, as a nearly flat surface, into contact with the ground. A specimen is represented in this position, under a lateral view, in fig. *b*. The action of the frontal cilia is then seen, as if evenly covering this surface, producing currents, which, however, do not form whirlpools. But suddenly the little animal ceases feeding; rears itself on its toes till it stands nearly erect; balances itself for a moment; evolves from each side of the head, by a kind of turning inside-out, a remarkable ear-like process, which is clothed with much stronger cilia. The action of these immediately begins to form vigorous circular vortices, of which the "ears" are the centres, and in the same instant the animal shoots forward with beautiful ease and precision, on its even course, revolving slowly as it goes.

Some very favourable observations on the animal, made when I could look down directly on the head in a vertical position, have revealed some organs, which are doubtless vehicles of sensation, though I can but very uncertainly conjecture their office and value. At the back of the head there are two very minute prominences, each of which is terminated by a tuft of bristles. These organs are very generally found in the wheel-animals, and are in many species much more developed, and more favourably situated for observation, than in this case. They appear to be tubular prolongations of the skin, within which a piston-like body moves to and fro, carrying at one end a tuft of bristles, which diverge when protruded from the tube, and attached by a muscular cord at the other end to the interior of the body. A nervous thread in some species is seen to pass from the brain to each tube. The organs may be considered as analogous to the antennæ of insects, though even of these we are not quite sure of the function.

In our *Eosphora* there is seen, seated in a central depression between these two antennæ, a little wart, of which I cannot suggest the purpose. Directly at the front of the head, at the most advanced point of the animal, whether creeping or swimming, there are placed two symmetrical round specks of opaque crimson pigment, which come out with great brilliancy when the animal is viewed under sufficient magnifying power by reflected light. Dr. Leydig refuses to allow these to be organs of vision, but from repeated examination of them I have no doubt that he is in error, and that Ehrenberg was right in considering them eyes. Besides these, however, there is another red speck, which is without dispute of a visual character. It is far remote from the two frontal specks, being situate within the transparent skin, but near it, on the dorsal aspect, at about one-fourth (following the curve of the back) of the distance from the front to the origin of the foot. To make my readers understand its relations, I must describe a highly interesting and very remarkable organ.

In most of the animals which constitute this order, but seen with peculiar distinctness in the present subject, and in one which very closely resembles it in appearance, *Notommata aurita*,—there is seen a great ovate sac passing from the front along the back of the head, and terminating by a rounded extremity in the neck. This is occupied by turbid matter, and seems to be indubitably a brain; though it is quite without parallel among invertebrate animals to find any such concentration of the nervous substance in a single organ. We are accustomed to consider this character as exclusively belonging to the vertebrate classes, and to mark their superior position in the scale of being; the most sentient, the most intelligent, the most vigorous among the Invertebrata, such as the Spiders and the Insects, having no such simplicity of nervous structure, but only a series of centres, in the form of ganglions, more or less distributed through the whole body.

It must be borne in mind, however, that while, in the ROTIFERA, this brain is proportionally enormously large, and is quite alone—there being no other recognized concentrations of nervous substance than can be dignified with even the title of ganglions,—the neurine of which it is composed is in a very fluid condition; whence we may perhaps infer that its energies, whether for perception or will, bear no proportion to its volume.

Upon this great brain-sac, at the point that approaches nearest to the skin of the nape, but always with a forward aspect, there is seated a wart, often large and conspicuously hemispherical. The summit of this rounded eminence is crowned with a mass of red pigment, at times scarcely perceptible, then suddenly becoming visible like a flush of crimson, rich in hue, translucent, but sometimes pale and ill-defined. Upon this there lies a convex lens, which can, in many species —or, I should rather say, in many specimens of different species, for it is exceedingly variable and uncertain in this respect—be beautifully seen and clearly defined.

There is, in some species, a very curious and remarkable organ, in close connection with the brain, the use of which is altogether unknown. It is very distinct in this *Eosphora* and in *Notommata aurita*, and in one or two other species of the latter genus. It is a sort of globular sac, of large size, occupying the greater part of the bottom of the brain-sac, and sending up a rather wide tube through it. The globose extremity and a considerable portion of the tube are loosely filled with a substance, which, being opaque, appears dark when we view the animal by transmitted light; but when reflected light is brought to bear on it—a ray of the sun, for instance—it comes out quite white upon the general transparency. Ehrenberg assumes that it is of the nature of chalk, and so has called it *kalkbeutel*, or chalk-sac; but all that can with certainty be said is that it is a granular opaque white substance.

The appearance and motions of this organ and its contents add greatly to the interest with which the microscopist views one of these creatures. It is so unique, so unaccountable, so conspicuous, so beautifully defined, so evidently connected with the seat of intelligence, and with the most obvious organ of sense, that it exercises a kind of fascination on the observer, who is induced to watch it, and to linger upon it, in hope of solving the problems which it suggests. There, however, it remains, unsolved as yet, an inviting fortress of research for daring young physiologists to scale and take.

Let me say what further I have observed on the matter. The sac itself is frequently drawn with force to one side or other, or down in the longitudinal direction, or across towards the breast. These movements are effected by means of slender muscle-threads, which are attached to it and to various parts of the body. The white substance lies in irregular masses in the sac, sufficiently solid to push out the elastic sides in wart-like knobs, but loose enough to allow the light to pass through the interstices as they move over one another. The walls of the sac are contractile; for we see its form change, and instantly some of the granules of opaque matter are forced higher up in the tube, rising and sinking by turns, like the mercury in a thermometer. Indeed, a thermometer, with its tube and its bulb, and their contents, affords a capital illustration of the whole organ. By means of their motions we are able to trace the course of the tube much farther than when it is empty, and to see that it passes to the front of the head, between the two frontal eyes, and, bending over with an arch, is lost somewhere in the ciliated face.

The transparent body is inclosed in an equally transparent skin, which is quite flexible, but apparently tough and strong, like wet parchment. It falls into transverse folds as the animal bends and wriggles from side to side, allowing much freedom of motion; and these folds have the additional advantage of allowing the body to be lengthened or shortened, at the will of the animal, at both ends; the skin becoming inverted at two or three points, when either the head or the foot is drawn in. Both these movements are almost every moment being performed, to a greater or less extent; and are quite distinct from the evolution and involution of the head itself, by which the rotating "ears" are suddenly turned out for swimming, or the contrary.

In all this order the muscular system is displayed with a clearness far greater than in any of the forms that we have yet considered. As might have been presumed from the untiring, vigorous, precise, and most varied motions of every part of these minute animals — motions which excite the admiration of the observer who remembers their dimensions, —the muscles are exceedingly numerous and well developed. In every species in which the viscera present the requisite clearness (for some are so constantly opaque, either from the distension of the alimentary canal with food, or the successive growth of great turbid eggs in the ovary, that we can hardly discern any of the more delicate details of their internal structure), the great longitudinal and diagonal muscles are seen, in the form of broad tapes running freely through the body-cavity, inserted at each end into some part of the skin by terminations more or less branched and divergent. Some of these pull the head down, or to one or the other side, or to the back or front; some, attached at the infoldings, produce the telescopic inversions; some draw in the different joints of the foot, or move the whole foot, or each joint, in various directions, or separate the toes.

Other muscles are seen in the form of slender elastic threads, of which there are very many, crossing the body in various directions, attached by expanding ends to the different viscera and serving to move them quickly and vigorously. There are also bands which go transversely around the body, no one band, however, completing more than a part of the circumference: the action of these appears to be to narrow the breadth of the cavity, and so to protrude the extremities,—either the head or the foot, or both at once. Minute and complex muscles are also present in the interior of the head, and in the mouth (*mastax*) in great number, effecting the most precise and varied movements of these parts.

In order to render clear the form of the mouth in this order, I must again have recourse to a homely comparison. The parts, which, in the Builders,* I have endeavoured to illustrate by means of a cut apple and a set of pins, are all here, but they are so modified and changed in form and mutual relation that they can no longer be made intelligible by that device. Take away then the split apple, and substitute for it a pair of gardener's edging-shears, the blades of which stand in a different plane from the handles. Suppose there is but one handle (the pair being bound together, if you like), and the blades are hinged to its extremity so as to work while it remains fixed; now turn it up, so that the handle stands erect upon its top, and the blades work in the air nearly horizontally. If the blades were considerably widened, and curved downward at their tips like some surgical scissors, the resemblance would be perfect. These then are the lower jaws, technically termed the *incus*, the blades being the *rami*, and the handle the *fulcrum*.

Now then, for the upper jaws, we will again resort to the gardener's shed and rummage among his tools. We find a small digging-fork, such as can be used with one hand. It has three teeth, but that is of no consequence, for if it had but one, or any other number, up to seven or eight, it would still serve to represent the structure in some species or other. We take two such forks, and carry them away as lawful prize, in the name of science. But these also must be modified a little. The prongs must be bent abruptly at about a right angle to the handle, where, however, a hinge-joint must be made, so as to allow this angle to be considerably varied. Now take these modified forks, and set them up one on each side of the blades of the shears, handles downward, at such a distance that the prongs shall just rest on each blade. These are the upper jaws, technically *mallei*, the prong part being the *uncus* of each, the handle the *manubrium*.

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* See "Popular Science Review," vol. i. p. 478.

So we have the solid parts of this remarkable mouth. The prongs are fixed to the blades by elastic ligaments, so that when the former are drawn back the latter are stretched open, though both the blades and the forks have proper and independent movements, effected by means of muscles. The whole is contained in a three-lobed mastax, which does not importantly differ from that before described; and you may again have recourse to the parchment-covered cylinder of glass, to imagine the situation of the whole affair within the transparent body of the animal.

I have intimated that there is considerable modification in detail in these parts as found in different species. I have had specially in view *Notommata aurita* in my illustrative comparisons. In *Eosphora*, however, the blades are more pincer-like, coming together only at their tips, and the forks are but two-toothed, one tooth being more prominent than the other, and projecting over the blades, so as to cross with the tooth of the opposite jaw. In this, and in several other species, the mastax can be brought to the front of the face, so that the points both of the upper and lower jaws protrude; when so placed the animal frequently snaps them fiercely, and their close analogy with the two pairs of jaws in a carnivorous beetle becomes very evident; an analogy which, if we saw them only as they occur in many kinds of ROTIFERA, permanently inclosed far within the cavity of the chest, we could scarcely have imagined. It was this and similar observations which first compelled me to identify what has been commonly miscalled the "gizzard" in the ROTIFERA with the mouth and horny jaws of Insects.

The protrusion and snapping action of these two pairs of jaws are very strikingly exhibited by an attractive and beautiful race, the animals of the genus *Synchæta*. These are mostly found in large collections of clear water, such as lakes and ponds and reservoirs; rarely or never in those minute stagnant pools and ditches in which many ROTIFERA delight. They appear to require a wide area in which to expatiate, and the element must be of the purest, or it will not do for *Synchæta*. In such collections of water animal life is usually very scarce: statements which we see hazarded in common compilations of natural history, and slavishly copied and re-copied upon no authority, and with no test of their truth,—that "millions of animalcules inhabit every drop of water that we drink;" that "all the waters on the earth are absolutely swarming with life," and the like, are gross exaggerations. I have often examined with care samples of water from different localities, and in particular that supplied to the inhabitants of London by the different water companies, and found scarcely a trace of microscopic life,—no *Monads*, no *Euglenæ*, no *Infusoria* of any kind, no *Entomostraca*, no ROTIFERA, with the exception of a solitary *Synchæta*, or two, perhaps, spinning round, or two or three *Polyarthræ* jumping hither and thither, in a whole tumblerful. Sometimes such water is a little more peopled than at others; but its tenants are always, as a rule, few and remote. Like most popular fallacies, the notion I allude to rests on a substratum of truth; there are waters of which it would be strictly true to predicate such facts; but they are stagnant collections, usually very limited in area, in which decaying organic matter, vegetable and animal, affords abundant nutriment, in consequence of which the increase of animalcules, both by generation and spontaneous division, goes on with almost inconceivable rapidity.

To return, however, to our *Synchætæ*, the bright sparkling tenants of bright sparkling waters. They are comparatively of considerable size, several species being just discernible with the unassisted eye,—in other words, being above one-hundredth of an inch in length,—which, with a proportionate width, is about the limit of ordinary vision under favouring conditions. Their characteristic form is that of a boy's peg-top, especially if you select a specimen of the article with which Tommy Scapegrace has been for a week or two pertinaciously "digging" at his fellows' tops, by which means the iron peg has been driven further and further in, till only just the point projects: then you have the *Synchæta* exactly, the projecting point representing the minute foot with its tiny toes, which are commonly pressed together so as to look single. Now and then the animal rests on these united toe-tips, and rotates for several minutes, as if to maintain its character as a spinning-top; then away it shoots, and glides swiftly and giddily through the clear water by the hour together without repose; its enormous ciliary apparatus giving it great power of motion. The rounded front appears to be beset with cilia, but it forms a sort of indented crest or forehead, on which two antennæ are seated, as well as some pairs of curious stout branched bristles—whence the generic name, from σὺν (*sun*), together, and χαίτη (*chaite*), a bristle—and which then descends on each side in the form of two hanging lobes or ears, which are richly clothed with vibrating cilia, and are powerful auxiliaries to swimming. Strong circular currents are formed around each ear, while the animal rests on its toes. As it swims, it is almost continually contracting the enormous head with a sort of spasmodic twitching, which brings the ear-lobes momentarily to point forward, and alternately, and almost as quickly, recovering itself. The conical lower parts of the body are also frequently contracted in various degrees, and drawn up to either side in the most irregular manner. These movements are made by the various muscle-bands and threads, which exist in great number, and are discerned to much advantage, owing to the crystalline clearness of the tissues. This brilliant transparency is highly characteristic of the tribe, and, combined with their elegant form and sprightly motions, makes them rank among the most charming representatives of the class.

Just below the centre of the frontal crest there glows a very large oval eye of the richest ruby-crimson, through which the transmitted light is strongly refracted, as it would be by a globe of glass, showing that it is furnished with a true lens. This eye rests on a great mass of brain-substance, which when viewed from behind is seen to be much extended laterally. On each side of the eye are some large irregularly globose knobs of clear substance, from which descend two thick pieces, which meet at an angle near the middle of the body in the form of a massive **V**. From the summit of the frontal crest every now and then the animal protrudes two pairs of dark tooth-like points, curved towards each other, which open and close with a sudden snapping action, and are instantly withdrawn below the crest, where they can scarcely ever be discerned. For a long time I watched the recurrence of this motion, and marked the momentary protrusion of the jaw-teeth with the greatest interest, but with a most tantalizing impotence to solve their mystery. So totally unlike they seemed to the mouth apparatus in any other genus, that I longed for years to understand them. I saw by certain accompanying twitchings in the globose heads of the **V**-shaped body, that the protruded points were intimately connected with them; and I felt sure that if I could satisfactorily resolve them, I should acquire a flood of light on the as yet unintelligible structure of the mouth in the whole class. At length I thoroughly mastered it, and saw that it was by no means an abnormal apparatus, but essentially identical with the parts of what had been called the "gizzard" in the ROTIFERA generally.

The two branches of the **V** are the *mallei*, or upper jaws, invested with thick masses of muscle: the hand, or "fork," consists of a single finger, the tip of which as a sharp curved point projects from the investing muscle, which here becomes globose. A delicately subtle rod which rises between the limbs of the **V** is the *fulcrum* of the lower jaws, seen at some distance forward, whose blades curve backward towards the beholder (as he looks at it dorsally); the whole being well imitated by the figure of the garden-shears. The blades, however, are invested with thick globose masses of muscle, out of which the tips project, as the inferior pair of snapping points. It is the massive character of the muscular investments which during life so disguises the form of the apparatus; and this massiveness, as well as the inordinate size of the whole structure, amounting to fully one-third of the entire bulk of the animal, indicates a predatory power which is by no means inconsistent with the impression of ferocity conveyed by the vigorous, sudden and frequently-repeated snappings, even when there seems nothing present to snap at.

I have mentioned above the name of the genus *Polyarthra*. It is a member of this order, but with peculiarities which isolate it from all others of the class. This, too, is a very difficult subject to make out, and it requires a long-continued study of the species, pursued through a great multitude of individuals, and a large acquaintance with other forms for comparison, well to understand its internal organization. This difficulty is augmented by its swift motion, its irregular fitful leaps, and its extreme transparency, combined with high refractile power.

Its form is that of a crystalline cup, somewhat like the body of a wine-glass without any foot, but bearing many thin, sword-shaped processes, which proceeding from the breast commonly lie flat on each side down the body, the points projecting below. These are evidently stiff and highly elastic, and their use is manifest to any one who sees the creature in active motion. It swims with a rapid gliding progress head foremost; but at almost every moment it makes a sudden forcible jerk or leap backwards, or to one side; and that so quickly, that the eye often cannot follow it in the transition. The organs by which these jumps are effected are the long breast-spines, which are suddenly thrown out in various directions, and they may frequently be seen extended the moment after a leap, before they reassume their normal position. When we consider that the creature is jerked often four or five times its own length through so dense a fluid, we shall perceive how strong the muscular action must be which moves the lever-like spines. The creature is thrown irregularly, often with the side foremost, or the back, or made to perform a somersault in the act. It is probably a sensitiveness to danger or annoyance that prompts these violent leaps; at least it frequently performs them after a momentary examination of any floating matter with which its course brings it into contact.

This very remarkable animal deviates in several particulars from the rest of the order, and yet I think its affinities are with them. It has no semblance of a foot, and the investiture of the body forms a stiff shell (*lorica*), as we find in the following order. Yet this is very peculiar. The back appears to me to be covered with longitudinal plates, divided from each other, and crossed by very delicate, close-set lines (*striæ*). These plates appear to extend round to the ventral surface, protecting about one-third of the width on each side, and rising into a strong lateral point. The central third is occupied with membrane, which along the breast between the lateral points is rigid and shelly, but becomes quite flexible and skin-like towards the hind extremity.

The sword-like fins are exceedingly curious and quite unique; for though a genus named *Triarthra* is furnished with three long spines, by which it performs leaps, yet the structure of these organs is very different from that of the swords of *Polyarthra*, and the animal's affinities are with another order. These appendages are exquisite tests of the powers of the microscope, as well as of the skill of the observer. They are twelve in number, arranged in groups of three each, one group being set on each side of the dorsal, and one on each side of the ventral aspect, near the base of the projecting points of the breast. They are jointed, quite independently, on rounded shelly knobs, and are moved by strong muscles. Under graduated pressure I have brought out the four series of knobs, and the twelve fins with perfect distinctness, and have proved that the connection is that of true proper joints, like those of the limbs of insects. This existence of true joints, which is found in several other species of ROTIFERA, is one of the characters, on which I rely in maintaining, contrary to the opinion of Mr. Huxley and other excellent naturalists, the high place of the class in the natural system.

The fins are what botanists would call linear-lanceolate; very thin, with a midrib running throughout, acutely (in one case that I observed, rather abruptly) pointed, distinctly toothed along each edge, the teeth pointing forward. Their texture is excessively delicate, and shows oblique lines running to the notches; yet they are firm and highly elastic.

The female carries its eggs, after they are discharged, attached to her body for some time; another particular in which the species agrees with the *Brachionidæ*. The young student must, however, be on his guard against a very natural mistake into which I myself fell in my early study of these forms. Observing that many specimens of this species had little green egg-shaped objects adhering to their bodies, and knowing the egg-bearing habit of the species, I took for granted that these were the ova. At length, however, a specimen occurred with one or two manifest eggs, of much larger dimensions, and perfectly agreeing in form, colour, appearance, and proportions with the eggs of other ROTIFERA, adhering to the body, while the little green objects were there also. At length some of these latter, detaching themselves, swam away by means of their own cilia, and I perceived that they were parasitic INFUSORIA, of the genus *Colacium*, which ordinarily infest this species, as well as ENTOMOSTRACA. Thus maturer observation corrects the errors of inexperience.

One of the most remarkable forms of this order is the genus *Asplanchna*, so named because of a most strange and quite unparalleled deficiency in its organization. Furnished with a formidable pair of nipping jaws, a long gullet, a capacious lobed stomach, and a distinct pair of pancreatic glands, and being highly predatory and carnivorous, this animal has not the slightest vestige of an intestinal canal, the digestive stomach hanging like a globe in the centre of the capacious body-cavity, tied to various points of the walls by long elastic slender muscle-threads, which allow it to sway about. From the great comparative size of the animals—for they are among the very largest of ROTIFERA,—from the brilliant transparency of the skin, and from the smallness and paucity of the viscera in proportion to the capacity of the ample body, the organs can be determined and examined with unusual facility; so that I know of none that present so favourable opportunities to the student who wishes to demonstrate the anatomy and physiology of this charmingly crystalline tribe of animals.

It is interesting to remark that the ovary in this genus is of the ordinary structure, though small. The young, however, are hatched, one at a time, within the body of the parent; and an exceedingly curious and interesting spectacle is presented by the young animal, perfectly formed, with its eyes, its jaws, and all its other organs readily identifiable, occupying one-third of the volume of the parent, as it lies horizontally across the blunt sac-like extremity, occasionally working its jaws, and moving its viscera to and fro by means of its muscle-threads; the double integument of the parent and offspring no more interfering with distinct vision than two thin films of glass. There is an outlet for the young at the period of birth, but it has no connection with the alimentary canal.

In some of the species not the slightest trace of a foot is present, but in others there is a very small one, with two excessively minute toes.

Of the *habits* of the animals of this order, perhaps the most interesting examples are those afforded by two species of *Notommata*—*N. petromyzon* and *N. parasita*, which live—the former occasionally, the latter habitually—in the majestic rolling spheres which bear the name of *Volvox globator*. In an interesting paper by the Editor of this Review, the appearance and the salient points of the history of this remarkable organism, once considered an indubitable compound animal, now by most naturalists referred to the vegetable kingdom,—are well given.* Within the beautiful green spheres of the *Volvox*, *N. parasita* may be frequently seen comfortably lodged, whence Ehrenberg gave it the appropriate designation of "*the Pirate*." On examining several *Volvoces*, even with a pocket lens, we may frequently detect such as are thus tenanted by their containing one or more spots, differing from the young clusters in form and colour. Each of these spots is found to be a *Notommata*, snugly ensconced within the globe, in the spacious area of which it lives at ease, and swims to and fro like a gold-fish in a glass vase. We see it for the most part, however, clinging to the inner surface of the circumference, engaged in devouring the green monads with which its gelatinous expanse is studded, or else eating away the embryo clusters. The action of the protruded jaws of the *Notommata*, as it eagerly nibbles away at the monads, is very energetic; but its progress is not commensurate with its vehemence. I have not been able to see one actually detached and swallowed. Frequently two or more *Notommatæ* are found in the same *Volvox*, and I have seen as many as four, with an egg besides. They do not interfere with each other, but each pursues his own avocation.

It is chiefly the smaller *Volvoces* that contain the parasite, especially those which have the embryos very immature. I have not seen any *loose* in a large *Volvox*; but in embryos almost grown, and nearly ready for escape, I have several times seen a *Notommata*. If we wonder at this *Rotiferon* obtaining access to the interior of the sphere, we wonder still more at seeing even the young spheres, while yet within the mother sphere, thus tenanted, especially as the circumference both of mother and daughter appears unbroken. On careful examination, however, the parent *Volvox* shows places where the monads are interrupted; and I have thought that I could discover, in each case of a tenanted embryo, that its circumference had a ragged point.

The *Volvox* does not appear to suffer from the depredations of its ungrateful guest, for, though half of its young embryos may be devoured, it glides along with as swift and as majestic a course as ever; nor are the vibrations of its cilia intermitted, for any floating atoms that lie in its track are hurled away with impetuosity the moment they come within reach of this living whirlpool.

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* "Popular Science Review," vol. i. p. 57.

In some spheres we find eggs with *Notommatæ;* in some, eggs alone. Perhaps the parasite is always hatched in a parent *Volvox*, but the embryo globe is probably entered from without, and the *Notommata* is then expelled with it. The *Notommatæ* frequently eat their way out, and swim at freedom. Observing one, large with a nearly matured egg, in the globe of a small *Volvox*, I opened the latter with a fine needle, and freed the *Notommata*. This I placed in clear water, and added several *Volvoces* of various ages, taking care that none contained a parasite. I then watched its proceedings, to see if it would enter any one of the globes, but though in the course of its swift and headlong rotation it now and then came into contact with a globe, and would arrest its career to play over its surface, and even to nibble at it, it would presently dart away again, not entering one in the lapse of several hours. In the course of this time it deposited its egg loose in the water, which probably it would not have done had I left it to follow the dictates of its instinct.

For further details of the economy of this interesting creature I must refer to a paper of my own in the Transactions of the Microscopical Society of London for 1851.

EXPLANATION OF THE ILLUSTRATIONS.

Plate XIX.—Fig. *a* represents *Eosphora aurita*, seen from the back, the ear-like lobes evolved, in the act of swimming.

" Fig. *b* represents the same animal, seen from the side, in the position assumed in marching and feeding. Both figures are magnified about 250 diameters. From the life.

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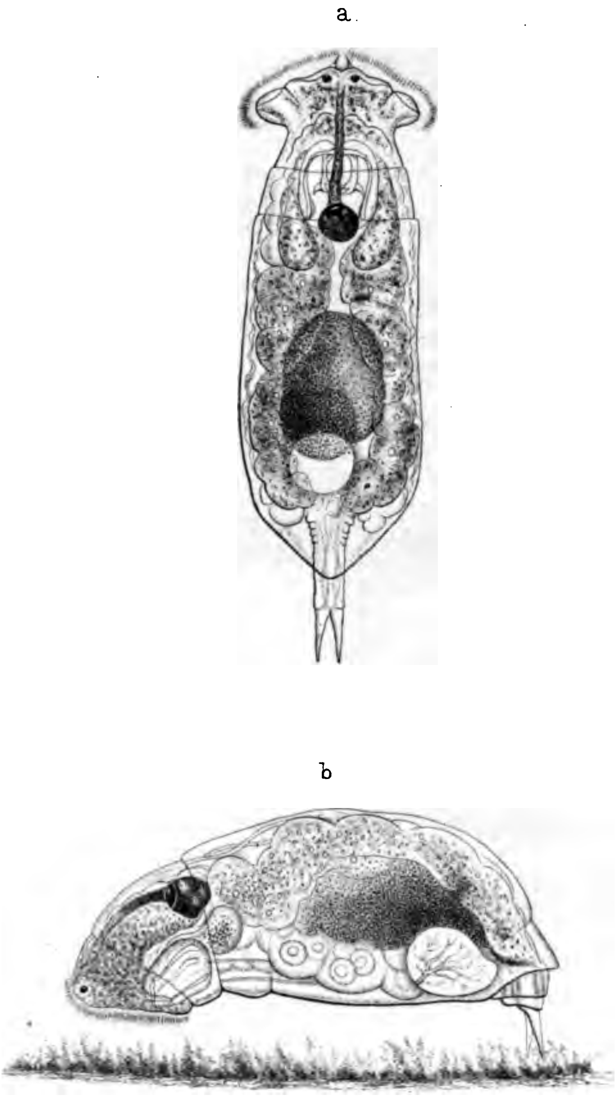

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Eosphora aurita.

ON THE MORPHOLOGY OF VINCA MINOR (SMALL PERIWINKLE).

BY JAMES BUCKMAN, F.L.S., F.G.S., ETC., PROFESSOR OF BOTANY AND GEOLOGY.

TIME was when the collecting botanist almost avoided all specimens of plants that were not typical in form; but since the immortal Goëthe propounded his remarkable morphological views, the aberrations of form assumed by some plants under extraordinary circumstances have been carefully inquired into, and their teachings made to explain the theories of plant structure—vegetable comparative anatomy—which knowledge is the very foundation of correct and philosophical classification.

Viewed in this light, examples of plants which were once set aside as *monsters*, are now carefully studied by the philosophical botanist, and as these often occur unexpectedly, I purpose from time to time to offer the readers of the POPULAR SCIENCE REVIEW some illustrations of the more remarkable examples of morphological changes which have as yet come before me, or which may hereafter reward my search.

Now, in following out this plan no very lengthened description will be required, because even the student will at once recognise the meanings of the drawings; when, however, we have a tolerable series of cases before us, it may perhaps be well to recur to them, in illustration and elucidation of the remarkable views and generalisations such objects cannot fail to establish in the philosophic mind.

Our first specimen then is that of the *Vinca minor* (the Lesser Periwinkle). Plate XX., fig. 1, is a magnified drawing of a flower only partially expanded; in this the petals will be seen to be united into a tube, which has been opened to expose the curious columnar pistil and the five remarkable stamens. Here the style, of most elegant form, is surmounted by a stigma which is externally covered with fine bristle-like hairs, so pointing in every direction that, like a modern bristle door-mat, it is certain to sweep off whatever it may come near. Now, in the unexpanded flower the five two-lobed anthers converge over the top of this stigma; but as the flower opens, and is exposed to heat and sunlight, the anthers burst; and simultaneously with this the column or style of the pistil elongates, and in its upward progress effectually sweeps off the liberated pollen (A 1), and thus the office of fertilization is brought about.

Figs. 2 and 3 are illustrations of a monstrous change in these simple arrangements. In these the petals have increased beyond the normal number of five, to ten; they are not united into a tube by their claws, but are separate and distinct. Of these, half are distinct petals, as fig. 4; and alternating with these, and forming an inner whorl, will be found stameniferous petals, as fig. 3*a*, and figs. 5 and 6.

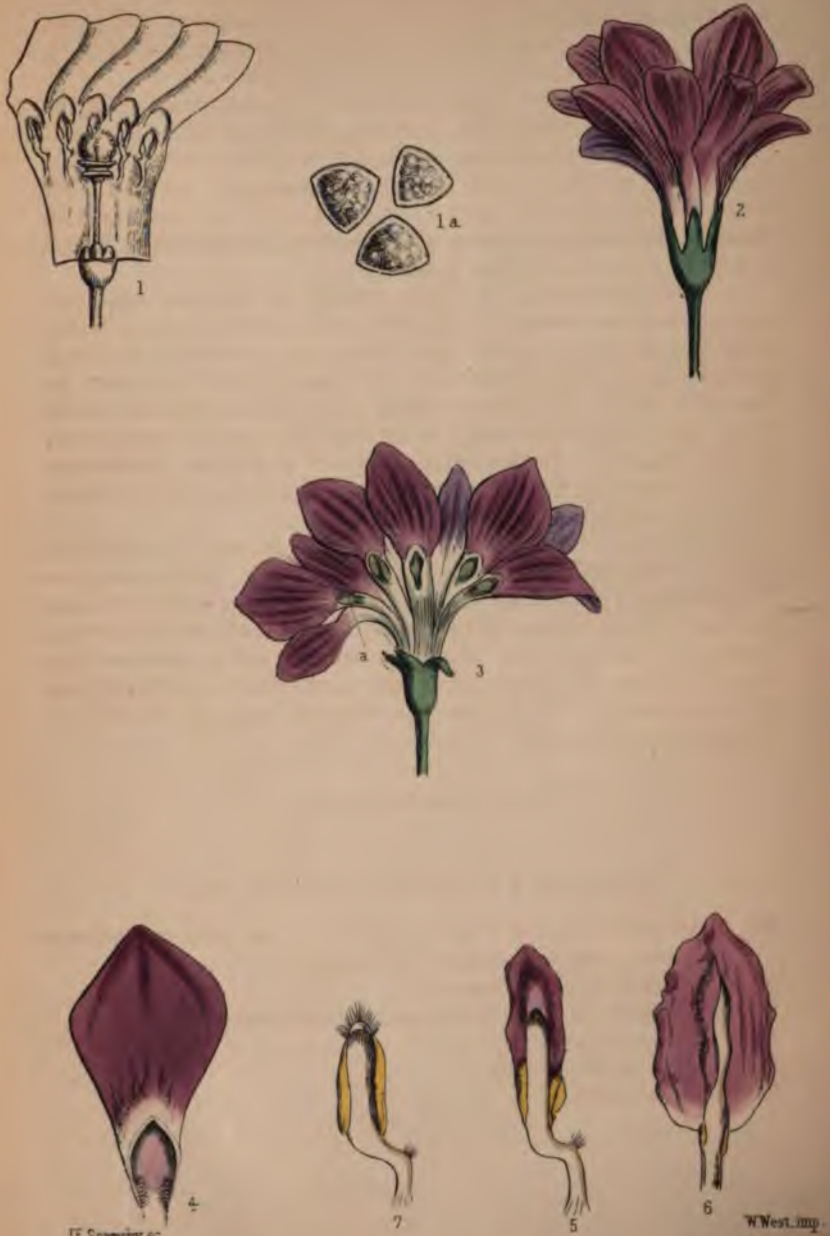
In some examples of these monstrous flowers, enlarged stamens may be seen, as fig. 7; in which case the pistil is found usually more or less perfect, and the petals not wholly, but only partially free: here fertilization is possible, but there can be but little doubt that the resulting seed, on cultivation, would bring about the more complete change of form as represented in figs. 2 and 3. In this latter the pistil is abortive, consisting only of a small point representative of the style, and of course the seeds are not developed.

Illustrations of the above may be found in what is called the Double Periwinkle planted on most rockeries, and about the "wilderness," especially of our older gardens; and they may be viewed by the tyro in botany as objects of great interest, illustrating the fact that what was once called a monopetalous corolla is after all composed of five petals united at their base by cementation, whilst here the stamens may be viewed as metamorphosed petals.

EXPLANATION OF PLATE XX.

Fig. 1. An opened flower of *Vinca minor* showing the pistil just before it pushes through the stamens by elongation.
Fig. 1*a*. Pollen of ditto, 300 diameters.
Figs. 2 & 3. Metamorphosed flowers, each with ten distinct petals.
Fig. 4. A separated petal.
Figs. 5 & 6. Petaloid Stamens.
Fig. 7. A true stamen.

Plate. XIX.



J.E. Sowerby sc.

W West imp.

Morphology of Small Periwinkle.

OUR BRITISH JUNGERMANNIÆ.

BY MARGARET PLUES.

THERE is a group among our cryptogamous plants of exceeding delicacy of structure and grace of form, which lack their due meed of observation from plant lovers. These are the Jungermanniæ, or Liverworts, constituting the main part of the family of Hepaticæ, the second section of the Calyptreæ of Mohr, divided by him from the Mosses, because of the want of an operculum or lid, the distinguishing mark in the moss group. These Jungermanniæ exhibit cellular structure to perfection. With a pocket lens you can see the transparent network of the leaves, and under the microscope they become most beautiful objects. No male organs are discovered; the seeds are extremely minute, they are mingled with elastic spiral threads, and contained in a receptacle of a round or oval form; when the seeds are ripe the receptacle bursts into four parts, and thus when empty appears as a minute brown cross. This receptacle is supported upon a foot-stalk of greater or less length, sometimes measuring but a few lines, and sometimes attaining the length of two or three inches; it is slender, colourless, and almost transparent, and resembles spun glass; the oblong cells of which it is composed appear like joints under the microscope. The stalk rises from a tubular perichætium or calyptra formed upon the stem, or frond; it varies in form, being sometimes entire at the mouth, and consisting simply of the tube, but more frequently torn and jagged, and often accompanied by sepal-like formations.

The Jungermanniæ are parted into two great divisions: those assuming a form such as we are familiar with in many sea-weeds, are called Frondosæ; and those with distinct stem and leaves, rather resembling mosses in their growth, are named Foliosæ. These latter are subdivided into Stipulatæ and ex-Stipulatæ, according to whether or no there are rudimentary leaves, or stipulæ, under the stem, accompanying the true leaves.

During the damp, mild weather of this winter and early spring, I have amused myself by the constant search for Jungermanniæ. One wood, with many paths and a pleasant name—the Chase Wood—has been my hunting ground, if I may be permitted to use a term so at variance in meaning from what it formerly signified.

Imagine, then, a dull February day, with the roads two or three inches deep in mud, and most uninviting for pedestrians, a thick fog hanging over the meandering Wye and its adjacent meadows. Turn with me to yon wooded hill; even the deep lane with high banks of red sand, where the dying fern fronds droop hopelessly, and the mosses display their most brilliant green, is less dirty than the main road. The lane leads past a quarry, and then you enter the wood. Perhaps the trees do drip a little, but only in the lower part; the path ascends by rocky steps, it is wide enough to save any danger to the looped-up dress from the long grass at its edges, and as you rise higher and higher the atmosphere becomes clearer. Red rock, cropping out here and there, retains but little of its original form, for the mosses clothe it thickly about its base, and our friends the Jungermanniæ cling upon the damp bank beneath it. We find large leaves, or more properly fronds, lapping one over another, each rooted to the wet ground; this is one of the Frondose Liverworts, *J. epiphylla* (No. 13). Out of the substance of these fronds, a little cup or calyx has arisen, presently a tubular calyptra will spring from it, then a long transparent stalk, bearing the round receptacle, which will burst into a cross of four broad valves. The fronds are dark green, shaded with brown or purple in the centre. This Liverwort is a common object, not only in our woods, but on damp garden walks, and even on flower-pots in wet places. A closely allied species, with fronds curled at the edges, and of a paler hue, flourishes about a small spring in the same wood; its large white calyptræ, and the narrow segments into which the receptacle splits, are clear marks of distinction: *J. pinguis* (No. 12). Clustering about the tree roots, and sometimes growing in patches on the lower part of the bark, you find the slender fronds of the *J. furcata* (No. 11). Its pale green hue attracts the attention, and its crowded fronds have a mossy appearance; it is only when you stoop to examine it closely that you recognize their strap shape.

Nearing the top of the wood, splendid blocks of pudding-stone guard the path on either side. Here it well repays the botanist to take out his glass, and examine the plants on the southern surface. I could name half a dozen mosses, and nearly as many lichens, as well as several ferns, among those rock dwellers; but I must restrict myself to Jungermanniæ. To begin at the base, where the mosses grow thick, we find interlacing amongst them the familiar branches of the *J. Asplenoides*, the largest and most frequent of the Leafy Liverworts (No. 1). This plant is rare in fruit, but its long branches, with their outspread rows of horizontal leaves, pale green and glittering, are to be seen on every damp hedge-bank or shady copse. The slender *J. bidentata* grows under that rock also, its foliage still paler, its stems tender in the extreme; it is slightly branched, its calyx and calyptra are large in proportion to the rest of the plant, and deeply cut; the footstalk is long and the receptacle oval. The fruit was formed, but not opened in February (No. 6). Higher up the rock, but also sheltered by mosses, flourish the minute but sturdy stems of the *J. obtusifolia* (No. 10). These stems are not branched, and stand almost upright. The leaves are divided into two rounded lobes; the smaller is turned in front of the stem, and the larger wraps round to the back, thus giving the appearance of two rows of leaves on either side the stem. The fruit springs from the end of the stems, but it does not appear till much later in the year. Ascending yet higher on the rock, to a level with your own shoulder, you find a still more minute Jungermannia covering the stone in filmy patches of pale green. This is the *J. reptans* (No. 7); it is a fairy-like plant, its main stem and plentiful branches only occupying about a quarter of an inch. The lens shows the leaves to be placed alternately on either side the stem, each cut into four sharp points. A paler film, studded with minute oval objects, which prove on examination to be calyptræ, and from which issue numerous glassy threads, bearing a forest of microscopic brown crosses, proves to be a patch of *J. connivens* (No. 3); every tiny leaf standing forth as a perfect crescent under the microscope, though the naked eye can hardly distinguish the perfect plant from an Alga, except the fructification be present.

The trees form favourite habitats for the Jungermanniæ. In the Chase Wood we find not only the *J. furcata* on the bark near the roots, but large patches of a closely interlaced Liverwort. On this mild February day the foliage is a bright green; the forked branches bear calyptræ on their summits, from whence issue very short foot-stalks bearing slightly oval receptacles; or, if these have burst, crosses of four blunt valves. This is the *J. complanata* (No. 4). Upon the same tree possibly, or failing that, on a very near neighbour, Liverwort patches of a very different hue are flourishing and displaying their seed-vessels. The overlapping leaves, with their rounded forms and unbroken margins, show an affinity with the *J. complanata;* but a marked difference will be seen on applying the lens, for beneath each leaf is a rounded stipule, proving it to belong to the Stipulatæ division of the foliaceous group. This Jungermannia spreads in wide patches, generally of a reddish hue: *J. dilatata* (No. 8).

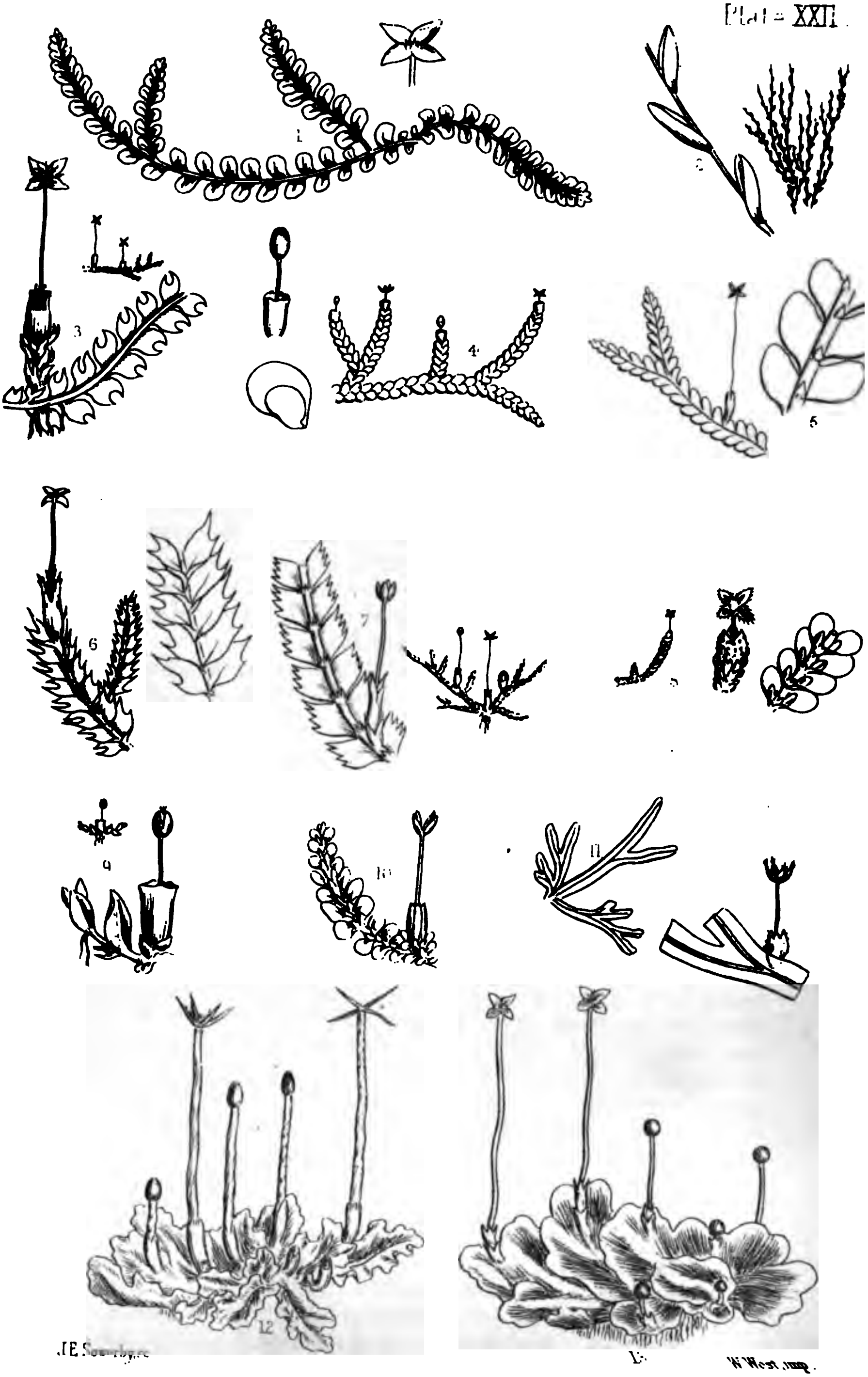
The wood grows thicker, and we find ourselves descending between oozy banks of red earth. Here a partial greenness tempts us to a closer inspection, and we recognize tiny crosses of warm brown. We feel sure we have got a Jungermannia, but we must apply the lens before learning its form. The stems are short in the extreme, and bear sharp pointed leaves on either side; at its summit it carries a calyptra cup-shaped; the oval receptacle rests on a very short stalk. The colour is yellow-green, and the plants grow in a scattered fashion, not in a dense patch, as is usual with Jungermanniæ. Its turned-in leaves procure it the name of *J. calyptrifolia* (No. 9). The same bank nourishes the long straggling branches and glittering foliage of the *J. polyanthos*. On close examination we find small stipules cut into two points beneath the stem, from behind which little rootlets spring, fastening the branch at a distance of every few lines to the clay. A few weeks later and the patch will be strewn with white calyptræ, glassy footstalks, and slender crosses (No. 5). Once more rocks rise on the side of the path, but here it is the north exposure that nourishes the Liverwort. Numerous slender branches of dark green form a network, and we are inclined to pass them by as Algæ, and irrelevant to the subject of the day; even the lens fails to discover anything more than mere inequalities in the thickness of the threads. But we carry it home, plunge it in water for a few moments, and apply the microscope; and lo! the threads are rounded stems, set on either side with closely compressed leaves, clasping with their heart-shaped bases the slender stems; it is the *J. cordifolia* (No. 2). Other overhanging rocks are draped with the spreading branches of the robust *J. platyphylla*, lying one above another tile-fashion, and affording good handfuls of foliage. The colour is olive-green, varying in hue, and the fruit is rare; but no moss is commoner on the perpendicular surface of rocks than this Liverwort. Here the leaves are divided in two lobes, like those of the *J. obtusifolia*, but the smaller lobe is turned to the under side of the branch; there is a stipule also, about the size of the smaller lobe, and situated under the stem, between the rows of turned-in lobes; this gives an appearance of very close and abundant foliage to the under part of the branch. Trees growing about these rocks have occasionally a very verdant patch at their roots; the strikingly fresh green attracts the observer, and he finds the plant to be *J. serpyllifolia*, a minute Liverwort with entire leaves placed horizontally on either side the stem, and moderately branched.

Let us search the woods and hedges immediately around us, and ere a score of moist days have been thus passed, few will be dissatisfied with their sheet of Jungermanniæ.

EXPLANATION OF PLATE XXI.

Fig. 1. Jungermannia Asplenoides.—2. J. cordifolia.—3. J. connivens.—4. J. complanata.—5. J. polyanthos.—6. J. bidentata.—7. J. reptans.—8. J. dilatata.—9. J. calyptrifolia.—10. J. obtusifolia.—11. J. furcata.—12. J. pinguis.—13. J. epiphylla.

Plate XXII.



J.E. Sowerby, sc.

W. West, imp.

Jungermannia.

COLOUR-BLINDNESS.

BY JABEZ HOGG, F.L.S., &c.

THE eye—that index of the soul, that channel of human knowledge—conjures up a host of feelings when the mind is directed to it, as an object of especial attention. Of the five senses with which most of us have been blest, the loss of sight seems to be the greatest calamity that can befall us. Reflect for a moment on the condition of those deprived of this exquisite gift. To what a sad state are they reduced who, in a perpetual darkness in the midst of light, have not anything like a conception of what we mean when we talk of the golden sun, the bright stars, the ever-varying tinted flowers, the beauty of spring, the glow of summer fields, the ripening fruits of autumn, and all beside that clothes the face of nature so beauteously to our eyes!

Our theme, however, is not with those who have so large a claim to our sympathies, but rather with others among us who suffer from a partial kind of blindness,—not necessarily a mechanical or optical defect, but one which is almost unknown or unrecognized by those who suffer from it, and, being ignorant of its existence themselves, cannot easily be persuaded to believe it.

An explanation of this curious defect will be worth while listening to, the more so as many eminent philosophers have suffered from it; and it is perhaps owing to this circumstance that so much time and attention has been given to the investigation of so curious an anomaly. It is well known that a ray of light, from any source, may be divided by means of a prism into a number of rays of different refrangibility, forming a series, and called a spectrum, the most familiar instance of which is the rainbow. The drops of rain falling between the sun and the eye act as so many prisms, and each ray is thereby bent or refracted to a different angle, the red most and the blue least; and as thus the rays of light are made to enter the eye separately, we have produced the beautiful prismatic phenomenon of the rainbow, the outermost colour of which is red, the innermost violet, and the intermediate, from slightly intermixing and overlapping each other, we respectively name orange, yellow, green, blue, and indigo. The three homogeneous colours—yellow, red, and blue—have been shown by

Mr. Field, in a satisfactory manner, to be in the numerical proportional power as follows:—yellow, three; red, five; and blue, eight. When these three colours are reflected from any opaque body in these proportions, white is produced; they are then said to be in an active state, but each is neutralized by the relative effect that the others have upon it. When they are absorbed, they are in a passive state, and black is the result. When transmitted through any transparent body, the effect is the same; but in the first case they are material or inherent, and in the second impalpable or transient. Colour therefore depends entirely on the reflective or refractive power of bodies, as the transmission or reflexion of sound does upon their vibratory powers. By the undulatory theory of light, philosophers account for the variously coloured rays of the solar spectrum, by calculating the differences in the frequency of the vibrations of each ray—that is, the rays of light are supposed capable of vibrating in waves of different lengths. The shortest waves produce violet light, the longest red; and with such precision have some of the more complex phenomena of light been studied, that mathematicians have absolutely been able to calculate the number of vibrations necessary to produce an impression of either white or coloured light. For instance, the periodical movements of the medium in white light regularly recur at equal intervals, five hundred millions of millions of times in a second of time; in the sensation of redness, our eyes are affected four hundred and eighty-two millions of millions of times; of yellowness, five hundred and forty-two millions of millions; of violet, seven hundred and seven millions of millions; and so on.

How seldom do the most reflecting amongst us think, as we gaze on the flowers composing a bouquet, and inhale their fragrance which perfumes the surrounding air, that in order to distinguish the yellow tint of the laburnum, five hundred and forty-two millions of millions of undulations of light must occur; that the ruby fuschia requires the eyes to receive four hundred and eighty-two millions of millions of undulations in a second; that the violet's tint is only distinguishable when seven hundred and seven millions of millions of vibrations have penetrated to the sensitive retina!

When objects are illuminated by homogeneous yellow light, the only thing which can be distinguished by the eye is the difference of intensity or brightness. It is now a generally received opinion that different bodies, according to the manner in which their minutest particles are arranged, possess the power of variously absorbing a part and reflecting the other portion of the rays of light that fall upon them; and that on the proportions of the rays absorbed and reflected does the colour depend, and that it is not a part of the object itself. The meaning of this will be best understood by an example. When a ray of light falls on the green grass, part of the ray is absorbed and part reflected, and the grass is only seen with the part that is reflected. The green we see consists of the original white light, deprived of a portion of its rays by absorption. It is, therefore, partial darkness, and not absolute light, consequently not a pure and absolute green, but only a residual group of the unabsorbed coloured rays. A poppy appears scarlet, as it absorbs all the colours of the rays except red, and hence its peculiar tint; but if it be looked at through green glass it will appear black: as the poppy only reflects the red ray, this is absorbed by the green glass. The red of the rose, the blue of the violet, the yellow of the jonquil, are due to their absorption of all the rays excepting the red, blue, and yellow. The pale-tinted rose, almost white, reflects nearly all the coloured rays. We can, therefore, easily perceive, without light, the face of nature would be that of a world in mourning; it is light that enlivens the scene, painting the exterior with a beauty, richness, delicacy, and harmony that man vainly attempts to rival. Colour is so dependent on light, that when artificially produced, as by candle or gas, from not being pure, many things appear of a different colour, as is well known by the lady who attempts to choose a ribbon or the artist who paints a picture by artificial light: a blue being mistaken for a green, and a green for a blue. On a moonlight night we cannot distinguish the colour of a chimney-pot; and were we to take a number of pieces of cloth, or different coloured papers, and examine them by the bright light of the moon, and write on the back of each the colour it appears, we should be astonished in daylight to see how much we had been deceived as to the true tint of each.

Assuming, therefore, that the sound eye can see perfectly well three simple colours—red, yellow, and blue—and that all the rest of the colours of the spectrum are mixtures of these with each other, let us now proceed to inquire what is the peculiar condition of sight in those persons who, being unable to distinguish certain rays, are, as we have already stated, *colour-blind;* but not necessarily owing to disease of the optic nerve or retina, but simply arising from inability to recognize those rays of light which consist of pure red.

Professor Maxwell, who has closely and philosophically investigated the subject, says:—"The mathematical expression of the difference between the colour-blind and ordinary vision is, that colour to the former is a function of two independent variables, but to an ordinary eye of three; and that the relation of the two kinds of vision is not arbitrary, but indicates the absence of determinate sensation, depending upon some undiscovered structure or organic arrangement, which forms one-third of the apparatus by which we receive sensations of colour.

"Suppose the absent structure to be that which is brought most into play when red light falls on our eyes, then to the *colour-blind* red light will be visible only so far as it affects the other two sensations, say of blue and green. It will, therefore, appear to them much less bright than to us, and will excite a sensation not distinguishable from that of a bluish-green light."

That is to say, the normal eye reduces its colour-sensations to three, and analyzes white light into three coloured elements, one of which is red; and that the colour-blind eye, on the other hand, reduces its colour-sensations to two, and analyzes white light into two elements, neither of which is *red;* for colour-blindness takes its character more from its non-recognition of red than its positive recognition of yellow and violet. An essential distinction which can thus be drawn between perfect vision and colour-blindness has induced Sir J. Herschell to adopt the term *dichromatic* (cognizant only of two colours) to characterize the colour-blind.* We shall now examine how far the withdrawal of the red ray affects other colours. In the first place, all the light tints, as well as the dark tints, are liable to be mistaken for each other. The orange is no longer red and yellow, but dark yellow; the yellow is purer, the green distinct, the blue purer, and the indigo and violet no longer red and blue, but blue mixed with more or less black, the violet being the darkest, as containing least blue in proportion to red, while the red part itself, though not seen as a colour, is not perfectly black. The red is generally seen as grey, or neutral tint; the orange as a dingy yellow; the blue as a dirty indigo, and the violet as a pale blue, mixed with black and grey.

In the "Philosophical Magazine" for 1857 and 1862 will be found a series of experiments, instituted by Professor Maxwell, to test the accuracy of his own eyes in distinguishing between shades of colour; and his data may be followed by any one curious in the same field of inquiry. A large variety of all shades and tints of coloured wools may be used for the purpose. They should be placed in a mixed heap before the person, who must try to arrange and name them, beginning with the darkest, and putting those tints together that are most alike. Professor Maxwell adds, "The intelligent testimony of the colour-blind may supply a sure foundation for the theory of vision."

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* Dr. Wilson employs the term *chromato-pseudopsis* (false vision of colours), as it, he says, "very fairly expresses the general character of the affection, which more frequently shows itself as an insensibility to certain colours, than as a total inability to discern them."

Many other curious and interesting points in connection with the philosophical part of our inquiry might be entered upon did the space at command permit us to do so; but enough has been said about light and colour to enable the reader to comprehend the more intricate part of the subject we are about to enter upon—namely, colour-blindness. As I have already said, the defect does not necessarily interfere with the integrity of the eye as an optical instrument. Indeed, in a case recorded by Dr. Wilson of a Mr. R——, an engraver, he counts himself not a sufferer, but a gainer by his colour-blindness. "Thus, an engraver has two negative colours to deal with—black and white. Now, when I look at a picture, I see it only in white and black, or light and shade; and any want of harmony in the colouring of a picture is immediately made manifest by a corresponding discord in the arrangement of the light and shade, or, as artists term it, the *effect*. I find, at times, many of my brother engravers in doubt how to translate certain colours of pictures which to me are matters of decided certainty and ease. Thus, to me it is valuable. I am totally unable to retain certain colours in my mind, nor able to give their names when shown to me a second time. Sometimes I can see some reds and greens by lamplight. A few years ago I ventured to buy some green baize; but unfortunately bought a very bright red, which was excessively painful to my eyes by lamplight, but agreeable enough by daylight. One of my brothers is equally defective, and my grandfather was very deficient in his knowledge of colours. My sight is natural, and rather powerful; for I am able to see very minute objects without assistance from glasses, and I can also see very distinctly with but little light. With regard to the rainbow, or solar spectrum, I can see clearly there are different shades of colour, but I am unable to say which is the red. The violet and yellow are very clear and distinct."

Those who have compared a coloured drawing or oil painting with an engraving of it will appreciate the nature of the difficulty which Mr. R—— so easily surmounts. In heraldic engraving, for example, a system has long been followed of representing each colour by a separate set of marks. It comes, however, to be a very curious question whether this gentleman's version of a picture would satisfy one whose perception of colours was perfect. Professor Kelland and Dr. Wilson think it would not, as they have observed in the course of their inquiry that colour-blind persons arrange different shades of the same colour according to their intensity, in a series which did not satisfy their eyes; and further, that their arrangement of different colours according to their intensities seemed discordant to both these gentlemen.

The celebrated Dugald Stewart, and Dr. Darwin, the poet and botanist, could only by shape discover the difference between cherries and the leaves among which they grow. Dr. Dalton, the propounder of the atomic theory in chemistry, was not convinced he was colour-blind, until by accident observing the colour of the flower of the *Geranium zonale* by candlelight in the autumn of 1792. The flower was pink, but it appeared to him almost a sky-blue by day: in candlelight, however, it was astonishingly changed, not having then any blue in it, but being what he called red; forming a striking contrast to the blue. He also compared sealing-wax to one side of a laurel leaf, and a red wafer to the other, and his doctor's scarlet gown to the leaves of trees. "I have seen specimens," writes Dr. Dalton, "of crimson, claret, and mud which were very nearly alike. Crimson has a grave appearance, being the reverse of every showy or splendid colour. The colour of a florid complexion appears to me that of a dull, opaque, blackish blue upon a white ground. Diluted black ink upon white paper gives a colour much resembling that of a florid complexion. It has no resemblance to the colour of blood." From the care with which Dr. Dalton investigated his own defect, it has become popularly known as "Daltonism." Nor was his case at all peculiar with regard to flowers, for the colour-blind are constantly found unable to distinguish the petals of the scarlet geranium from its leaves, the flowers of the wild poppy from the unripe corn amongst which it is growing. Moreover, those who thus mistake scarlet, regard green as a darkish colour, and confound it with drab.

The number of cases now upon record of persons afflicted in this way are very considerable; though until within these late years it was supposed to be confined to a very few individuals. From the calculations of various authors, that *one* person out of every *fifteen* is colour-blind, and from the investigations of the late Dr. Wilson upon 1,154 persons at Edinburgh made in 1852-53, we gather that—

1 in 55 confounded *red* with *green*,
1 in 60 confounded *brown* with *green*,
1 in 46 confounded *blue* with *green*;

hence, that *one* in nearly every *eighteen* had this imperfection. Professor Siebeck found five out of forty youths in the two upper classes in a school at Berlin colour-blind. Professor

Prevost considers it occurs on an average in one out of twenty persons; and Wartmann, whose investigations almost exhaust the subject, thinks this estimate is not exaggerated. M. Lubeck rejects this conclusion as unsound, from the observations having been made in England and Germany, where blue is the prevailing colour of the eyes; and it is a question with him whether it occurs so frequently in persons the *irides*-colour of whose eyes are black or hazel. In answer to this, it seems the great majority of cases examined by Wartmann had black irides.

This consideration, however, cannot be of much importance beyond the physiological correspondence observable with the ophthalmoscope between the colour of the iris and the fundus of the eye, by the relative determination of the *pigmentum nigrum* * in persons of different complexions. In adapting the eye to varying intensities of light, the pupil (iris) of course acts a principal part as to the amount of visual rays received, but its changes cannot have much effect upon the varying intensities of the vibrations to which the supplementary phenomena of colours are ascribed. It is the intensity rather than the character of the light that the iris controls, and which remains the same whatever sensation of colour is excited. It is different with regard to the influence which sex seems to exert, for on an analysis of upwards of two hundred cases, the proportion of males affected is no less than nine-tenths of the whole. Thus, it would appear that in this respect, the perfection of vision, the ladies have greatly the advantage over the gentlemen. There is, however, an interesting account given by M. Cumer of a family of thirteen females (extending through five generations), all of whom were colour-blind. On the other hand, Dr. Bronner, of Paris, relates the case of a learned chemist, a German, whose two daughters were free from their father's defect. The children of the eldest one were likewise unaffected, whereas three sons of the youngest were all colour-blind. A grandson, also, the son of one of these latter, inherited the defect. In the "American Journal of Medical Science," 1854, another similar case is reported, where seventeen descendants, chiefly males, of the maternal grandfather all inherited colour-blindness.

The two elder sons out of a family of four suffer from this defect. The second son, now an eminent sculptor, early in life exhibited great taste in drawing and painting, but after some few years of study was obliged to relinquish the art, in consequence of the many blunders he committed in the combination of his reds and greens. Upon my directing his attention not long since to a very brilliant carpet, having a bright scarlet ground, with vivid green fern-leaves running over it, he said he could see no difference except in the warmth of tone of the red over the green. I have repeatedly examined his eyes with the ophthalmoscope without observing any departure from the normal condition, except a small difference in the colour of the fundus; the choroid has less blood circulating in it, and the pigment-coat is certainly much paler. But this must be taken with some modification, as the irides are brownish, scarcely hazel: in every other respect the sight is nearly normal, as may readily be surmised, from his successful career as a sculptor. An only sister, it should be mentioned, paints to perfection.

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* I make no apology for introducing technical terms into this paper, since the anatomy of the eye is so well explained in a paper which appeared in the January part of the present year. See page 220.

From other instances on record, it would seem that colour-blindness is frequently compensated for by the greater exactness with which distant as well as near objects may be perceived, and this, too, in a comparatively obscure light. We find in the "Glasgow Medical Journal," vol. ii., a case of the kind with some valuable remarks by the individual himself. "All objects whatever, when viewed at a distance, lose their local colouring, and assume more or less of a pale azure blue tinge, which painters term *the colour of the air*: this is interposed between myself and a distant object. No colour contrasts to me so forcibly with black as this azure blue; and as you know that the shadows of all objects are composed of black, the forms of objects which have acquired more or less of this blue tint from being distant become defined and marked by the possession of shadows which are invisible to me in the more highly coloured objects in the foreground, and which are thus left comparatively confused and shapeless masses of colour. So much is this the case with me when viewing a distant object, as to overcome the effect of perspective, and the shading in the form and the garments of human beings at some distance from my eye is often so predominant, and marks them out so distinctly, as to overcome the effect of diminution of size; and although I see the object most distinctly, I am unable to tell whether it be a child near me or a grown-up person far off."

Both Professor Wartmann and Dr. Wilson examined and tested individuals who corrected by the touch erroneous judgments which they formed regarding colours. A case of the kind came under my own observation which I shall presently relate; and I know and have met with very many instances in the totally blind able to distinguish every variety of colours by the delicacy of the sense of *touch*: they tell me there is a sensible difference in the degree of heat conveyed to the point of the finger.*

The fact that a difference of tint is recognized, although the eye of the colour-blind person does not appreciate any difference of colour, as red and green, when compared together, and that every one is educated to call things by certain names, whether he understands the meaning or not, may help to explain the slowness with which this defect is discovered; and again, that the report of every case is rendered hopelessly imperfect from the impossibility of subjecting the eye to the test of colour.

In the "Philosophical Transactions for 1859," Mr. W. Pole, a well-known civil engineer, thus describes his own case:—"I was about eight years old when the mistaking a piece of red cloth for a green leaf betrayed the existence of some peculiarity in my ideas of colours; and as I grew older continued errors of a similar kind led my friends to suspect that my eyesight was defective; but I myself could not comprehend this, insisting that I saw colours clearly enough, and only mistook their names. I was articled to a civil engineer, and had to go through many years of practice in making drawings of the kind connected with this profession. These are frequently coloured, and I recollect often being obliged to ask in copying a drawing what colours I ought to use; but these difficulties left no permanent impression, and up to a mature age I had no suspicion that my vision was different from that of other people. I frequently made mistakes, and noticed many circumstances in regard to colours which temporarily perplexed me. I recollect in particular having wondered why the beautiful rose light of sunset on the Alps, which threw my friends into raptures, seemed all a delusion to me. I still, however, adhered to my first opinion, that I was only at fault in regard to the names of colours, and not as to the ideas of them; and this opinion was strengthened by observing that the persons who were attempting to point out my mistakes often disputed among themselves as to what certain hues of colour ought to be called." At length Mr. Pole when about thirty years of age committed a glaring blunder, and this circumstance led him to make an investigation of his case, which ended in his discovering that he was colour-blind.

All who have investigated the subject of colour-blindness agree that in the greatest number of cases it is not a disease, but rather a remarkable type of vision. It is known, however, that the peculiarity exists sometimes as a matter of degree, and that an abnormal sensation of colour may be received, but of so short a duration and corrected spontaneously as to be a source of little inconvenience, and even passes unnoticed. But as many important facts in connection with the subject have come to light, it is now made essential, and very properly so, for every driver or guard of the railway train to pass an examination as to his power of perceiving and distinguishing different coloured signals used on railways. Dr. Wilson goes further, and says: "It admits of a question whether the demands of public safety would be best met by excluding colour from railway and ship signals, or by excluding the colour-blind from the office of signalmen." Red and green lamps are employed as signals at sea, as well as on railways, and many appalling accidents, no doubt, have been occasioned by mistaking the colour exhibited both on sea and land.

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* Professor Tyndall enters fully into all these matters in his work on "Heat as a Mode of Motion" (reviewed in the present number). The eighth chapter treats of the relations of light, heat, and colour, and will be f deeply interesting to those who have read this article, and d information on the subject.—Ed.

A mistake in colour may arise from the fact that the sensation can only be prolonged for a very *limited time*. Thus, whenever any one looks fixedly at a bright object placed on a surface of a dark tint, and then closes his eyes, or transfers them suddenly to another ground of a lighter colour, he immediately perceives an image presenting a colour complementary to the one last observed. This arises, also, when the eyes have been fatigued by the prolonged observation of a coloured and very bright object, as a coloured light, and then suddenly turned to look at another object of a different colour; or when the eyes are fatigued by overwork and hours of watching. Many remarkable cases are on record where coloured vision has been suddenly produced. The particulars of a somewhat remarkable case lately excited some attention, and a medico-legal question of importance was raised. The sufferer, a corn-dealer, brought an action against a railway company for compensation, inasmuch as that after the accident every thing appeared yellow, and all qualities of flour, therefore, were alike in colour. The evidence chiefly depended upon the man's own statement, as it appeared the eyes were carefully examined, and yet none of the medical witnesses could give any explanation as to the cause of the yellow vision. The jury, however, awarded £1,200 damages; and as a certain amount of coloured vision is not unfrequently found to be associated with paralysis, it is not difficult to believe the retina may have been partially paralysed by the severe shock received in this railway collision.

But whether we regard colour-blindness as only a curious physical phenomenon, simply a defect, or as a positively abnormal condition in some one or more of the structures of the eye, it may be truly said we know so little concerning its true nature, that I need offer no apology for the few remarks I am about to add upon it. As I have often met with it associated with actual disease, and since by the invention of the ophthalmoscope we are now enabled to observe many very curious changes in the internal eye before unrecognized, it is not improbable by its aid we may ultimately discover some structural differences in the eyes of the colour-blind. And if the proposition be well founded that the colour of the internal membranes of the eye must affect its perception of colours, then the choroid, which is the most fully coloured of the tunics, and the one most liable to vary in extent and depth of coloration, must have a very important influence on colour-vision. Now, in the few cases that I have had the opportunity of examining, I noticed a considerable difference both in the quantity of pigmental colouring matter, in the size of the vessels, and in the amount of blood circulating in the eye. This will be seen by any one not conversant with these matters, upon comparing the size, and perfection of the vessels in the otherwise sound eye represented in figure 1 with that of figure 2, a drawing made from an eye in a state of disease, the person having also been colour-blind prior to the loss of sight. This, however, I am ready to admit, may prove to be the exceptional and not the general condition of the eyes in the colour-blind; further investigations alone will settle this point. The seat or cause of the defect probably lies altogether beyond our reach; but whatever we can learn concerning it is certain to be of service in determining the extent to which we may hope to cure or alleviate this affection of sight.

The first case of colour-blindness that fell under my notice was that of my late talented friend, Mr. Angus Reach, whose untimely death has been so much and so justly lamented. He was incapable of distinguishing green, and only partially so red. With him both were nearly the same. The former would sometimes appear more of a pink than even red. He had altogether but a very poor conception of the primary colours. This I detected on one occasion when endeavouring to demonstrate the gradation of beautiful colours displayed by some objects made to depolarize light when placed on the stage of my microscope. After a long endeavour to convince him of the fact, as he could see nothing wonderful in it, I discovered that he was unable to name the colours correctly; and he then told me he had always been indifferent about them. To prevent error he had been accustomed always to avoid describing them, except in relatively as light and

and white. He remarked of the *vin-o*

to him it appeared so like ink that he once found himself endeavouring to write with it. He saw no red in it.

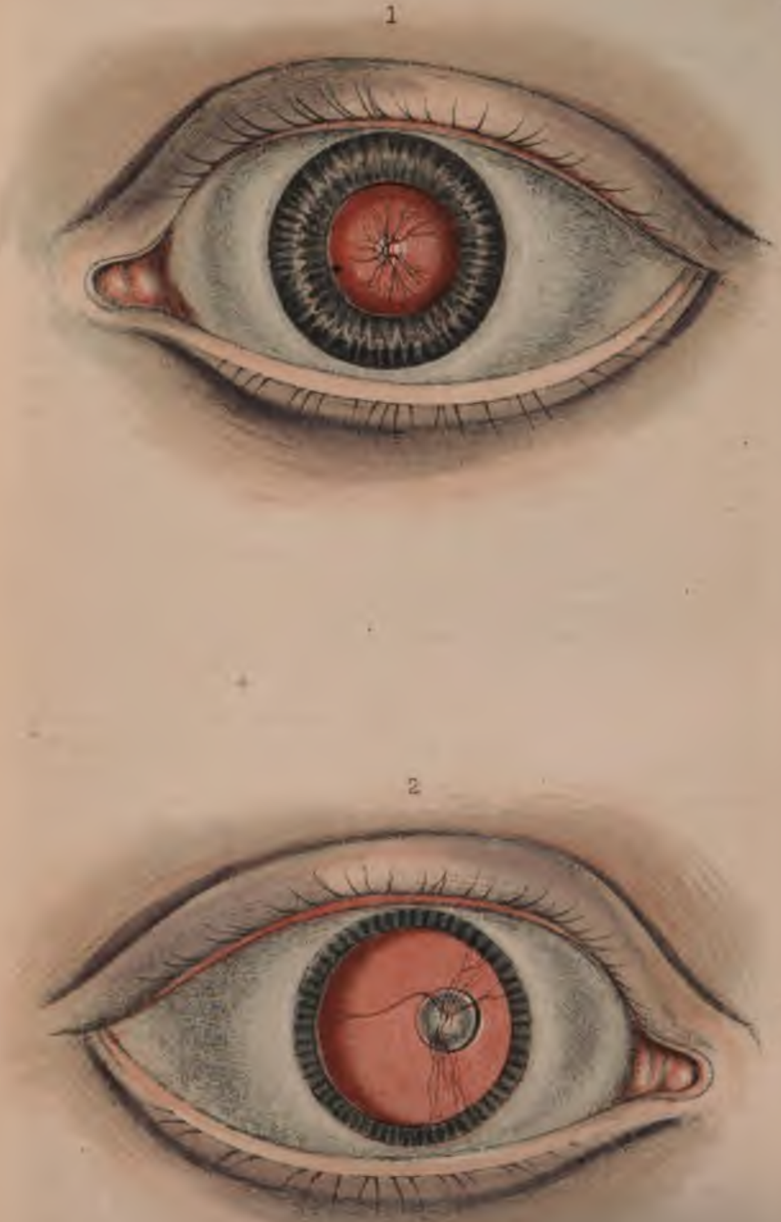
At this time, unfortunately, my attention was not so much drawn to ophthalmic disease as it has been since, and I omitted to make such an investigation of this remarkable affection which in one so fully capable of affording accurate information as to the phenomena observed would have been so valuable. Very soon after he was attacked with the first symptoms of softening of the brain, which gradually progressed during the two years his life was prolonged.

It has since several times occurred to me that the defective condition of sight might have been connected with the early development of the disease in the brain. The extreme condition of colour-blindness in which I found Mr. Reach's eyes must have been a progressive aggravation, for otherwise it is most probable more notice would have been taken of it than seems to have been the case. Indeed it might have been induced as the first symptom of an overworked brain, as I have had opportunities since of observing instances of colour-blindness arising from general disturbance of the system, and disappearing as this was corrected and relieved.

In another case, the fundus of the eyes upon examination were seen to be very pale; the defect gradually yielded to proper treatment. The gentleman, Mr. Raith, first noticed many peculiar appearances when looking at green leaves, chiefly so if growing with grass; then all appeared elongated and serrated. Even the leaves of trees—a willow-tree in particular—were not only indistinctly seen, but were very much serrated. Red flowers of most kinds could only be distinguished by their form from leaves; the exception to this was when they were globular in their form, as the dahlia.

Mr. W. Butcher was early put to the carpet trade, and after a short time he discovered some defect of sight which ultimately proved to be colour-blindness. By close observation he made himself well acquainted with the proper names of colours, and so kept his defect from those about him. By educating the eye to the peculiar *warmth* imparted when all the colours in carpets were said to harmonize, he was enabled to raise himself to the position of a salesman in a large house of business, and ultimately became travelling salesman. He has four brothers living, all of whom are colour-blind. Taking up the prismatic colours, he could distinctly see the line of demarcation between them, but confounded purple and crimson, pink and blue, red and green; and on placing before him a series of reds, scarlets, greens, and browns, he said, "They are all a mass of confusion, and it is totally impossible for me to distinguish one from the

Plate XVI



Ophthalmoscopic appearances.

other." Orange and yellow were selected easily, and appeared very bright to him.

About six years since, whilst in good bodily health and vigour, his sight began to decline, and now, for some months past, he has been quite blind. The present appearance of the internal eye when examined with the ophthalmoscope is shown in figure 2. It is technically called *white atrophy*—that is, the blood supply to the optic nerve and retina is in some way cut off: in consequence the vessels are very small and nearly obliterated; the choroid coat is sharing the general disorganization.

These are only a few of the facts which have been brought to our knowledge in connection with the very interesting subject of *colour-blindness.*

EXPLANATION OF PLATE.

Fig. 1. An enlarged view of the colour-blind eye free from other defect. The outer dark-coloured ring is the iris. On looking through the pupil, the circular opening in the iris, with the opthalmoscope, we first see a bright pink background, the choroid coat; this with the optic nerve constitutes the *fundus oculi*. The small and nearly centrally *situated* circular disc observed when the eye is turned a little inwards, is the optic nerve, and from its centre issues the vessels of the retina. Artery and veins closely accompany each other for a short distance, and then divide, first into two branches, one of which, with its vein, is seen to proceed upwards, and another pair downwards; and after passing the margin of the optic nerve they diverge, and again subdivide, split up into numerous smaller branches, some of which come forward to the ciliary processes. The vascular choroid coat imparts the pink colour to the back of the eye, which is nearly all reflected to the eye of the observer. The only difference observed in the eye of the colour-blind is the paler appearance of the fundus, or choroid coat, and occasionally whitish interspaces indicative of a small and languid blood supply.

Fig. 2. Shows the internal eye in an advanced state of disease, and is drawn from the eye of Mr. Butcher, who, it will be noticed, suffered from colour-blindness years before his disease deprived him of sight. It cannot, therefore, be supposed that his colour-blindness was in any way owing to the disease which destroyed vision. The pupil is nearly fully dilated, forming a part of the diseased condition; consequently, a much narrower ring of iris is seen than is given in Fig. 1. The *fundus oculi*, choroid coat, is very deficient in blood, which gives the mottled appearance, and indicates a state termed atrophy, in which the optic nerve and vessels of the retina is seen to share the supply of blood to retina and choroid, being in some way impeded, or nearly cut off, probably by a tumour forming in
the brain in close proximity to the optic nerve
the gentleman was in good health. and
say to what he can attribute his

REVIEWS.

THE PHYSICAL GEOLOGY AND GEOGRAPHY OF GREAT BRITAIN.*

GEOLOGY is as yet an infant science, but nevertheless an infant of prodigious size. From a few tangible and undoubted facts, geologists have been able to deduce as it were a great scheme, the history of the world's life. It consists, no doubt, in great part, of speculations and theories, many of which, in the advance of science, may prove false; but by continual observation and unwearied perseverance we are gradually arriving at the truth.

Scarce fifty years have passed since William Smith, "the father of geology," laid the basis on which all modern discoveries have been founded, and what was once considered a useless and "dry" study, now interests not only the learned in science, but all classes of society, who are eager to obtain some knowledge of the structure and nature of the world they inhabit. The Government has for two or three years past—with great credit to itself—encouraged a taste for science among the working classes, by evening lectures from the professors in Jermyn Street, and the crowded benches of the lecture-hall show how well their efforts have been directed. A course of six lectures on the physical geology of Great Britain, lately delivered to working men by Professor Ramsay, and ably reported by Mr. Mays, is now before us. The subject is treated in a manner at once interesting, instructive, and worthy of the President of the Geological Society. The way in which the connection between the scenery and geography with the geology of our island is shown, forms one of the chief merits of Professor Ramsay's course. Those who have listened to the course, or read the report, cannot fail to find a new interest in the country around them. Go they to the mountains of Wales, the Highlands of Scotland, the downs of the English south coast, or the plains of East Anglia,—all have a fresh beauty; each valley tells its tale of denudation by some roaring sea, or elsewhere by a mountain torrent; here is evidence of a mighty iceberg, there the course of a great river. A pleasure before unknown is now found in climbing the hills of Worcestershire, or the noble pass of Llanberis; for Professor Ramsay tells us something about each, as he opens to our view the waves that long since surged on Malvern's sides, and the glaciers slowly grinding out their road among the mountains of Wales, leaving as their sole memento in these warmer days, the charming lakes and torrents so well known to the lovers of Cambria. Before, however, proceeding to these generalities, a lecture is devoted to the explanation of the nature of the two great classes of rocks, the Igneous and Aqueous, with the sub-class of Metamorphic rocks, which were changed after deposition by the sudden heat of liquid lava. The nature of denudation is also explained, and, in illustration of the enormous power of running water, Professor Ramsay alludes to the Niagara falls; thus, "denudation" in the geological sense of the word means the stripping away of rocks from the surface by some agent, so as to expose other rocks beneath. Now, water running over the surface, wears away the ground over which it passes, and carries away detrital matter, such as pebbles, sand, and mud; and if this goes on long enough, there is no reason why any amount of matter should not in time be removed. For instance, we have a notable case in North America of a very considerable result from denudation now being effected by the river Niagara, where, at the Falls, the river has cut a deep channel through the rocks about seven miles in length. The proofs are perfect that the Falls were once at the escarpment, which is at the lower end of what is now this long gorge; that the river, falling over this ancient escarpment, by degrees wore for itself a channel backwards and backwards, about a hundred and sixty feet deep, through upper strata that form a great plateau.

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* "The Physical Geology and Geography of Great Britain." A Course of Six Lectures delivered to Working Men in the Museum of Practical Geology, Jermyn Street, by Professor A. C. RAMSAY, President of the Geological Society. London: Stanford.

Probable calculations show, that to form this gorge a period of something "like ten thousand years has been employed" The manner in which deposits of mud, clay, limestone, &c., have been formed, is carefully described. As an example of the immense amount of mineral matter which water may carry in solution from rocks, the springs near Bath are mentioned, which yield 181,440 gallons of water per day, holding in solution 3402 lbs. of salts, equal to 420 tons per year; a quantity sufficient, if compressed and solidified, to form a column 9 feet in diameter and 140 feet high. Rivers, too, contain exceedingly large quantities of mineral matters; the Thames at Teddington carrying along in its waters an amount equal to 33,497 tons per annum. The second lecture is devoted to the geology of Scotland, the various phenomena of metamorphism, and the nature of the igneous rocks. The various strata forming the surface of England and Wales, and their peculiarities of structure, form the subject of the third lecture. A very interesting ideal section is given, from Wales through Gloucestershire to the Eocene beds of Hampshire; and the bearing of the geological structure of the country along the line of section upon its scenery is described: the clays forming plains; the limestone, hills with escarpments suddenly rising from the flat surface below, their faces being washed away by the geologist's giant "denudation."

Perhaps the most interesting lecture in the series is that in which Professor Ramsay describes, according to a view which he has lately advanced, the origin of the Scotch and Welsh lakes. For this purpose he takes us first to Switzerland. Here he shows us the snow-capped Alps, with their valleys each containing a great glacier. The glacier formed by the compression of snow, which accumulates in masses on the mountain sides. Fresh ice is thus continually added to the mass behind, so that the glacier moves slowly down the valley, grinding out its bed, and constantly replenished from behind. Rocks and stones of all sizes continually fall from the neighbouring peaks on to the surface of the glacier, many slip into the abundant fissures, and thus get under the huge mass of ice, which, as it slides along, scores and scratches them, and also causes them to scratch the rock which forms the glacier-bed. When the glacier reaches a lower level it melts, and consequently deposits its freight of stones. As the glaciers are persistent, large heaps of stones are thus formed, which glaciologists term "terminal moraines." In consequence of the increase of temperature, the glacier at its lower extremity is much thinner, and wears away less rock than it does nearer its source; and thus a curved basin is formed, in which the glacier terminates. Now Professor Ramsay shows us that the great lakes of Switzerland are all situated in such basins as these, formed by great glaciers whose beds can be traced up the mountain valleys, which existed when the North of Europe was in a much colder condition than at present. In the same way he demonstrates to us that many of our Welsh and Scotch lakes have been similarly formed; for in the mountain valleys of Scotland and Wales we find the scratched stones, the furrowed rocks, and the "moraines," which are undoubted evidence of the existence, in these valleys, of glaciers. At the extremities of these valleys are the lakes, for the existence of which Professor Ramsay thus accounts. He does not, however, tell us how the trout got into these lakes, as it does not come under this branch of science; but the question is one of some interest, and is, we believe, rather a knotty point for Darwinians to work out. The Drift period, in which our island was covered with an ice-bound sea, is fully discussed in another lecture, and the well-known bone-caves and their fierce inhabitants are described. The silts and gravels of river valleys, and the flint hatchets of the Somme deposits, occupy a part of the lecture. We are sorry M. de Perthes' fossil jaw was not brought to light in time for Professor Ramsay's course, otherwise we might have had his opinion as to its claim to belong to a "real fossil man."

In his last lecture Professor Ramsay points out the influence which the geological structure of Britain has had upon its population, its manufactures, and general welfare. He shows how the mountainous parts of our country have formed a refuge for the ancient conquered tribes of Britain; how the coal-fields have centered around them an active and thriving population, engaged in manufacturing pursuits; and how the irregular contour of our coast has given rise to our great seaport towns. As to how and when man came to this part of the world, Professor Ramsay says: "We know that these islands of ours have been frequently united to the continent, and as frequently disunited, partly by elevations and depressions of the land, and to a great extent also by denudations. When the earliest human population reached their plains, they were probably united to the continent. Such is the deliberate opinion of some of our best geologists." He is able, in conclusion, to rejoice as a true philosopher over our present condition as an island: "We are happy, in my opinion, above all things in this, that by denudation we have been dissevered from the continent of Europe; for thus it happens that, uninfluenced by the immediate contact of hostile countries, and almost unbiassed by the influence of peoples of foreign blood, during the long course of years in which our country has never seen the foot of an invader, we have been enabled so to develope our own ideas of right and wrong, of political freedom and of political morality, that we now stand here, the freest country on the face of the globe, enjoying our privileges under the strongest and freest Government in the living world."

From the extracts we have given, it will be seen that the volume is replete with information and sound science. To the beginner it will be invaluable, to the adept it cannot but be of the utmost interest. It is, without exception, the most complete, accurate, and interesting little work on British geology that has come under our notice.

THE APE-ORIGIN OF MAN AND THE NEW PHILOSOPHY.*

DO any of our readers desire to become versed in the natural history of the man-like apes, from one or the other of which they are supposed by Professor Huxley and his school to be descended? to know what features in their human organization, or what phases in their development, have led transmutationists to proclaim their simian descent; or, generally, to become conversant with the phenomena of animal development, and with the evidences of man's great antiquity? Then we would recommend them to seek this information in the work under review, where they will find all these matters ably and concisely treated, and from which they cannot fail to learn much that will be new and interesting to them.

Are there any, again, to whom such knowledge would be rendered more acceptable by the accompaniment of a "slashing" attack upon our leading English naturalist, Professor Owen, whose opinions on some of the matters referred to are at variance with those of the author and his disciples; an attack made with weapons tipped, now and then, with a little sharp personality: have they a leaning towards extreme views in philosophy; or would they hail with pleasure the introduction of "sensation" writing into matters of dry scientific inquiry? Then we know of no better source from whence they may take a long deep draught than from the volume before us.

The object of the work appears to be twofold; first, to show that the differences between man and the higher apes are not sufficiently great to entitle the former to a distinct sub-class in the animal kingdom, but that he constitutes the highest family of the order Primates, in which the apes, &c. are included; and secondly, to enunciate the author's reasons for holding that man is a modification, by "natural selection," of some lower animal, probably a species of ape; and generally to expound the new philosophy which the author believes to be inaugurated through the publication of the Darwinian version of the transmutation theory.

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* "Evidence as to Man's Place in Nature." By T. H. HUXLEY, F.R.S. Williams & Norgate.

As to the first inquiry, the evidence contained in the work serves to show that the attempt to raise man too high, zoologically, is unwise; for that an examination of his *structure*, compared with that of the apes, reveals many marks of family resemblance. But as the terms "family," "order," "group," &c. are somewhat arbitrary (especially coming from a transmutationist), and as it is almost impossible to find two naturalists who can agree on the subject; one claiming for man a distinct kingdom by virtue of his psychical faculties, another denying him even an ordinal distinction, on the ground of his structural resemblances to the apes, and a whole file of zoologists standing intermediate between these two extremes;—we think our readers will agree with us that this should be a mere technical debate, and that it contains nothing calculated to provoke a popular controversy.

We quite agree with the author, that it is very absurd to "base man's dignity on his great toe, or to insinuate that we are lost if an ape has a hippocampus minor;" and we go with him to the very fullest extent in his views concerning the nobility of man (perhaps a little further), believing with him that "the unity of origin of man and brutes," *if it were proved*, would by no means "involve the brutalisation and degradation of the former." But who that lays claim to authority in these matters has ever made such assertions?

If Professor Owen had based man's dignity and salvation upon such trifling features in his anatomy (and we know of no one else to whom these remarks can be intended to apply), we should have been ready to applaud the author's attacks upon that naturalist, oft-repeated though they be, not only in this volume, but wherever readers or an audience can be found to whom such a controversy is deemed interesting. But we have never been able to extract from Professor Owen's publications or addresses (and we have read and heard several) any such inference; and when the author declares the question of the "posterior lobe, the posterior cornu, and the hippocampus minor," to be one affecting his own veracity, and time after time, even after he has declared that it is positively his last performance in that part, renews his onslaught on his illustrious contemporary, he must not be surprised if a discerning public begins at length to think that he resembles the valiant Irishman—who, returning from Donnybrook fair, disappointed of his scrimmage (or encouraged by it, we forget which), politely requested some one to tread upon his coat-tail,—that he is designedly bringing giants into existence in order that he may exhibit his valour in slaying them.

No; it is not Professor Owen who misapplies the structural resemblances and differences between man and the apes; but it is our author who does so. It is he who, ignoring man's *highest* mental distinctions, falls back upon his anatomy, and upon minor features in his organisation—nominally for the "ascertainment of the place which man occupies in Nature, and his relation to the universe of things;" but really in the endeavour to prove a pet theory, which may or may not be a correct one. As our readers are no doubt well aware, the author is a warm advocate of the theory of "natural selection;" indeed, in the opinion of some, he out-

Darwins Darwin. In another work[*] he says of Mr. Darwin's theory, that "the argument which applies to the improvement of the horse from an earlier stock, or of ape from ape, applies to the improvement of man from some simpler and lower stock than man;" for "it is perfectly demonstrable that the structural differences which separate man from the apes, are not greater than those which separate some apes from others."

In other words he says, that if the various species of animals be the result of a progressive development from one another, by the Darwinian process of "natural selection," he sees no reason why man should be exempted from the operation of this law; for in his bodily structure he is as nearly allied to his humbler fellows as they are to one another. And as regards the *mental* distinction between the two (man and ape), our author gets over the difficulty by making the broad assertion that "there is *no* faculty whatever that is not capable of improvement;" that "every faculty being *dependent upon structure* is varied and improved, with a variation and improvement in structure;" and that "the attempt to draw a psychical distinction" (between man and the animals immediately below him in the scale) "is equally futile," for that "even the *highest* faculties of feeling and of intellect begin to germinate in the lower forms of life."

Let us now, for the purpose of dispassionate inquiry into its validity, put the author's doctrine as follows:—

Mr. Darwin believes in the origin of species by "natural selection."

With a certain reservation, Mr. Huxley believes the same; he considers it "the only hypothesis regarding the origin of species of animals in general which has any scientific existence"[†] and as such he does not hesitate to apply it to the origin of our race, inasmuch as the structural differences between man and ape are no greater than between one ape and another; and there is no distinct line of demarcation in man's mental constitution, as compared with the animals which precede him.

Remembering, then, that we have so far *no proof that one species of ape is derived from another*, and that we are not now considering the question of man's place in the zoological system—that is to say, that we are not prosecuting our inquiries for the purpose of ascertaining whether the structural differences between him and the apes are sufficient to entitle him to the zoological distinction of a kingdom, class, order, or what not—we will now consider the conclusions at which the author has arrived in the present volume concerning the two forms of life, man and ape, and our readers shall judge whether or not they are favourable to his own doctrine.

Let us take his summing up of the evidence, first as regards the general resemblance between the two forms:—

> "In the general proportions of the body and limbs there is a remarkable difference between the gorilla and man, which at once strikes the eye. The gorilla's brain-case is smaller, its trunk larger, its limbs shorter, its upper limbs longer in proportion than those of man."[‡]

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[*] On our Knowledge of the Causes of the Phenomena of Organic Nature. Hardwicke.

[†] "Evidence as to Man's Plac

[‡] *Ibid.* p. 71.

Passing over that important feature, the naked skin, to which the author does not seem to think it necessary to refer, but which has done at least as much as his speech to bring into play his highest intellectual faculties, we now inquire what he has to say in regard to the extent of the difference in the capacity of the brain-cases.

"The *lowest* man's skull has twice the capacity of that of the *highest* gorilla."* This, he tells us, loses much of its systematic value when viewed by the light of certain other facts; but as we are not presuming to decide between Professor Owen and our author concerning the classificatory value of certain features, this supplement does not affect our inquiry; and we now proceed to seek information concerning the contents of the brain-cases—the human and simian brains; and we find that "it may be safely said that an average European child of four years old has a brain twice as large as that of an adult gorilla."

Coupled with the psychical differences between the two, this is rather adverse to the transmutation theory. But we must not be hasty in our conclusions; and passing over many such trifling distinctions as a tooth, "which projects like a tusk," we will try to find a brief general conclusion as to the differences between Homo and Troglodytes. And this is frankly and clearly given—in self-defence, by the way,—for the author tells us that "those who endeavour to teach what nature so clearly shows us in the matter are liable to have their opinions misrepresented and their phraseology garbled, until they seem to say that the structural differences between man and even the highest apes are small and insignificant."

No one can, however, thus misrepresent the author in this instance who says that "every bone of the gorilla bears marks by which it might be distinguished from a corresponding bone in man; *and that in the present creation, at any rate, no intermediate link bridges over the gap between Homo and Troglodytes.*"†

We place the utmost reliance upon Professor Huxley's testimony, for, as every one knows, he is a careful and conscientious observer and a comparative anatomist of the highest order. But this testimony compels us to ask: If the differences between them be so vast, and there is no intermediate link in the *present* creation, upon what does he base his belief in man's simian descent—Is the link to be found in the records of the past? And at the conclusion of his volume we find an explicit reply to our inquiry. It is "that the fossil remains of man hitherto discovered do not seem to take us *appreciably nearer* to that lower pithecoid form, by the modification of which he has probably become what he is;"‡ and if such a link exists, he intimates that it will probably have to be revealed by some "unborn palæontologist."

In this work, then, the evidences of the "probable" modification of man from the ape would appear to be that the structural differences between the two are enormously great, and that neither in the present creation, nor in the records of the past, do we find a link which brings the two appreciably nearer to one another! Upon what, then, *does* Professor Huxley found his belief in our "probable" descent from the apes?—and although we give him the benefit of his own word "probable," it is a probability conveyed to the world in such terms as to admit of little doubt that in the author's mind it is a conviction.

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* Evidence as to Man's Place in Nature, p. 77.

† *Ibid.* p. 104.

‡ *Ibid.* p. 159.

His theory is based upon another that is *probable*—namely, that of Darwin,—a theory which the originator does not see his way clear to apply to man; although, as Professor Huxley very properly remarks, "if Darwin's views are sound, they apply as much to man as to the lower animals." Nevertheless, Mr. Darwin is discreet, and "has said nothing about man in his book."*

But our author *does* apply Darwin's theory to man, for he accepts it as proved, subject to the production of a new species by artificial selection, which will render the same process by natural selection *probable*. As we have already stated,† the production of a new species by artificial selection has not yet been attained, although in the experiments made with this object, a hundred and fifty new *varieties* have been derived from one original stock.

If any of our readers, then, will take the trouble to compare the author's two works which we have been reviewing, they will find his argument on the ape-origin of man to run thus. In the first:—‡

"New and marked *varieties* may be produced by artificial selection. Artificial selection occurs in nature, and it looks very much as though all species had been produced in the same way, for their existence cannot be otherwise accounted for. This being the only rational theory, I accept it, subject to the production of an *artificial* species."

Then, in the work before us:—

"I will now show you that the differences between apes and men are no greater than between apes and apes; that they therefore come within the range of Darwin's law, and that one is probably a modification of the other by transmutation. The differences between apes and men are enormous, and neither in the present, nor in the records of the past history of nature do we find any intermediate form to bridge over the gap between them; but according to Darwin's theory, which I have accepted, subject to the artificial production of a new species (which will satisfy me that all species are the result of 'natural selection') man is probably descended from the ape; and probably some unborn palæontologist will discover the missing link." §

This, Professor Huxley, "may be truth, but it is not evidence."

We would not for a moment deny that Mr. Darwin's theory of transmutation by natural selection is deserving of all the attention that has been, or can be bestowed upon it by naturalists; and that whether the *law* be partially or wholly true, or whether it be false, its author has already contributed a noble chapter to the history of nature. So *may* our author's views in regard to man's simian descent prove to be correct, but at present his reasoning on the subject can only be compared to that of the servant-maid, who was asked by her mistress why she had placed the oysters out in the yard to be eaten by the cats? Her reply was that there were no cats about; and when her mistress inquired how she knew that, her ready response was, "because, if there had been any cats about, she would not have put out the oysters." The author may imagine that we quote this anecdote in a satirical vein; but it is not so. It occurred to us as an apt illustration in common life (and he has advised his pupils thus to test such arguments) of the substitution of intuitive impressions for calm and unprejudiced investigation.

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* Lectures to Working Men, p. 153.

† Popular Science Review, No. VII. p. 392.

‡ Lectures to Working Men.

§ Of course these inverted commas do not denote that we are using the author's words.

Such reasoning may be expected from those who are unaccustomed to dispassionate inquiry, but we do not expect to meet with it in such works as this.

And the author does not content himself with applying Mr. Darwin's theory to the ape-origin of man. He speaks of new "systems of theology or philosophy," propounded from time to time by men of genius, leaving his readers in doubt as to whether they must include Darwin's theory in the first or second system. Whether or not Professor Huxley lays claim to the authorship of a new doctrine, he certainly propounds one which partakes of the character both of a neosophy and of a neology; and although we find it somewhat difficult to make out exactly what are his dogmas, we shall endeavour to put them into a shape "convenient for common purposes," as he has done those of Mr. Darwin—with this difference, that we shall adhere as closely as possible to our author's own words, and let them speak for themselves. From his two recent works we thus extract the substance of his teachings:—

On the Universe in general.

All the phenomena of the universe have been produced alone by "what are termed secondary causes."[*]

1st. *On Organic Nature.*—The first creation of organic matter is a mystery which man is unable to solve, owing to the finite and restricted character of his faculties.[†]

2nd. Organic matter was created with certain properties, known as atavism and variability; the first being a tendency in the parental organisms to reproduce themselves in all their features;[‡] the second a tendency in the offspring to vary from the original stock. And the interaction of these properties of organic matter, with all the conditions of existence, vital and physical, which affect organized forms, has caused all the phenomena of organic nature.[§]

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[*] "Evidences," p. 108.

[†] Lectures, p. 135.

[‡] Lectures. Compare p. 89, l. 9 and 10; and 21, &c.

[§] Lectures, p. 137.

3rd. From the foregoing general laws, it is obvious that every species of organized being is a transmutation of some previously existing species; and there is no absolute structural line of demarcation between any group and any other, all being connected together by some transitional link.*

Of Matter and Mind generally.—All forces, vital and physical, of mind or matter, are "co-ordinated terms of nature's great progression from the formless to the formed, from the inorganic to the organic, from blind force, to conscious intellect and will." †

Of Sensation and Intellect.—What has been stated of the physical transmutation of the animal races applies also to their psychical or mental qualities; and "even the highest faculties of feeling and intellect begin to germinate in lower forms of life." ‡

ON MAN.

1st. Man is probably an improvement of some simpler and lower animal form §—probably of one of the apes.

2nd. There is a vast gulf between civilized man and the brutes. In the present creation there is no link to connect Homo and Troglodytes; and if ever there has been such a link, it remains to be discovered by posterity.||

3rd. There is no absolute psychical or mental distinction between man and the animals immediately below him in the scale.¶

4th. *Man is "the only consciously intelligent denizen of this world."* **

5th. *It is the faculty of intelligible and rational speech, which he alone possesses* (and the experience he has thereby accumulated) that has placed him in this high position amongst animals.††

6th. The experience which he accumulates during "the secular period of his existence," through the instrumentality of his speech and an occasional ray, which he thereby reflects from "the infinite source of truth," have transfigured him from his grosser nature and placed him in his high position. ‡‡

Some of our readers will, no doubt, be very much astonished at these doctrines; and we confess that we are the same; but it is not our

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* Compare Lectures, p. 143, last par.; p. 153, 2nd par.; and "Evidences," p. 109, last par.

† "Evidences," p. 108. ‡ *Ibid*, p. 109.

§ We say "probably," that we may not be accused of exaggerating the author's views; but a reference to p. 109, par. 2, will, we think, cause our readers to say we might safely have omitted the word.

|| "Evidences," p. 104, par. 1; p. 110, par. 1; and p. 159.

¶ *Ibid.* p. 109, par. 4. ** *Ibid.* p. 110, par. 1.

†† "Evidences," p. 112; and "Lectures to Working Men," p. 155, par. 3.

‡‡ *Ibid.* p. 112. The text is not very clear, but we have endeavoured to extract the author's meaning. If we have not succeeded, the fault does not rest with us.

business to be astonished, but to deal calmly with them from a philosophical and not from a theological point of view; and this we shall endeavour to do as briefly as possible.

If we believed that the author meant by his broad declaration concerning "all the phenomena of the universe," that all material operations in nature are carried on through the instrumentality of secondary causes, we should (as would most of our readers) quite agree with him, and should experience some surprise that he considers it necessary to tell the world so; but from the mode in which he braces together "blind force" and "conscious intellect and will," which he regards as "co-ordinated terms in nature's great progression," we are not able to put this construction on his words.

Let us for an instant test the accuracy of this generalization, which we can do without departing from the field of scientific inquiry.

Heat, as we understand it, is a "mode of motion;" and when a moving material form comes to a standstill, or when it changes its nature, motion ceases, and becomes converted or transformed into heat, and *vice versâ*. In like manner, according to the author's general law, when an individual *brain* ceases to act as a brain, that particular mode of action, thought or intellect, *ceases to be;* and the matter having been converted into a plant, the action of thought becomes growth, and the brain no longer thinks, but—say, as a cabbage—grows.

If the author meets us by stating that he has not denied the independent existence of thought or intellect—that the *matter* of the brain only *grows*, just as it afterwards grows in the cabbage—then we must inquire what he means when he says elsewhere* that "all functions, intellectual, moral, and others, are the expression or the result in the long run of structures, and of the molecular forces which they exert."

We shall be glad to hear that he means something that we have been unable to discover; meanwhile we must take his meaning to be as above stated, and turning to his neosophy for "evidences" of the truth of this doctrine, we find—what?

First,—That man has a secular period in his existence.

Then is his spiritual existence that of a cabbage or cauliflower?

Secondly,—That he reflects occasional rays from the "source of truth," which rays have transfigured his nature.

Then what becomes of these rays, or of their *influence* on him, after his brain has ceased to reflect them? Do they also act in the *turnip or broccoli?*

And again, the new philosophy teaches that "the highest faculties of feeling and intellect begin to germinate in lower forms," and that there is "no mental distinction between man and the animals which immediately precede him in the scale (a generalization which the author is shrewd enough to perceive to be indispensable to the complete acceptance of his physical teachings).

But what evidence have we of the truth of these broad assertions? Is it to be found in the statement that "man is the only *consciously* intelligent denizen of the world?" or that he *alone* is capable of "reflecting rays from the source of truth?"—truths which have therefore no *existence* for the humbler creatures placed under his care and presented to him for his purposes.

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* Lectures, p. 154, par. 2.

If we were to treat our author's doctrines as he has treated the cautious teachings of Mr. Darwin, we should ask him why, in that admirable monograph which he published some years since in the *Microscopical Journal*, of an infusorial form, "Disteria," he said nothing of its loves or of its hates?—for the "germ" of love should exist even in its microscopical bosom!

In what "lower form" does that faculty germinate which enables man to comprehend and admire the harmony of the universe and the wisdom of its Maker?

But the author's distinctions and designations, when he travels out of his own sphere, are most mysterious, and often contradictory. Granted that man is the only animal possessing intelligible and rational speech (another very decided distinction between him and the lower animals), what are we to understand by "rational" speech? Suppose the speech of the parrot had been ever so perfect, or that the gorilla had been endowed with this attribute; would it have enabled *them* to accumulate experience? Or if, on the other hand, these animals had possessed such mental qualities as are now the heritage of man only, but no speech, would they not have risen in the scale of intelligence? May not, even now, a "dumb" animal, a cat or an elephant, be taught to perform rational acts, in consequence of its possessing certain lower psychical qualities in common with man? What has speech done to render man "consciously" intelligent? what *can* it have done? We would ask the author to say frankly, is it not *one* of the many media through which human reason and human will act; and according to every principle that he has enunciated, is not "rational speech" a misnomer?

Whichever way he turns he convicts himself of inaccurate reasoning. If man's "rational" speech be something distinct from the utterances of the lower animals, and is rendered so by the possession of *reason*, then there is a distinct line of demarcation between them, which cannot be bridged over by the discovery of the fossil bones of "an ape more anthropoid,"* or "of a man more pithecoid."† If, on the other hand, man owes his reason to his speech (as the author would have us infer), then whence have those animals derived their reasoning faculties, which possess no speech, and why are those having imperfect modes of utterance not more rational than those which have next to none? And again we ask, how can man through his speech have become "*consciously*" intelligent, whilst all his lower companions have remained unconscious of their intelligence?

But we will not pay our readers the sorry compliment to suppose that in studying this neosophy, they will not be capable at once of distinguishing between *facts* and well-grounded theories, and accommodating generalizations; and we must repeat, therefore, in somewhat different terms, called forth by the appearance of this second work of Professor Huxley's, our reason for thus analyzing his doctrines.

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* Man-like.

† Ape-like.

They defeat what appears to us to be their author's most laudable object, namely, to secure to all men freedom of thought and expression on scientific matters; for in trespassing so rudely and inconsiderately beyond the limits of scientific inquiry, and indulging in wild speculations, he rather impedes than facilitates the progress of Truth.

Let us remind him, that if the organ of speech had been man's chief characteristic, he would *not* have been what he is. Guided by tradition alone, the multitude would have heard with satisfaction of an *auto-da-fé* in Jermyn Street, and no scientific inquirer would have been hereafter safe from martyrdom.

But are not such doctrines as we find in this work calculated to justify intolerance? Do they not give a colouring of justice to the anathemas which are, from time to time, launched against free scientific inquiry? We think they do, and our readers must decide for themselves.

If, then, it be the desire of the author and others (for he is not the only one to whom we could refer, who, under the guise of an iconoclast appears to throw doubt upon the evidences of design, and upon the all-pervading influence of a *First* Cause, in every natural phenomenon)—if, we say, it be the desire of the author, and others holding a high position in the scientific world, to see the veil of superstition withdrawn from human eyes, and the reign of reason ushered in, we recommend them to let the "scalpel" alone, and to allow the force of reason to burst the larval investiture of the age. *He* who teaches the insect to free itself from the pupa-case, will, *at the proper time*, aid mankind in its efforts in the same direction.

This operation the author can most effectively facilitate, by pushing on in his admirable and careful physical investigations, without importing into his works speculative theories and doctrines which have all the imperfections, without any of the moral excellences of those "superstitions" that they seek to supplant—dogmas which possess neither the recommendation of convincing the reason, nor of appealing to the heart.

Heat considered as a Mode of Motion. By Dr. J. Tyndall, F.R.S.

THE author of this excellent and interesting book states at the outset that he has in it "endeavoured to bring the rudiments of a new philosophy within the reach of a person of ordinary intelligence and culture." This statement is, we think, open to some explanation or correction with respect to the phrase "a new philosophy," especially as it is placed at the very outset of the work. The phrase manifestly refers to the view that heat is "a mode of motion."

To persons unacquainted with the present literature of the science of heat, or of the physical forces in general, such a view may perhaps be new; but to those who have perused the writings of Faraday, or particularly Grove, in his well-known work on "The Correlation of the Physical Forces," or of Helmholtz, Carpenter, and various other writers on the physical forces, heat, &c., such a view is not new, being abundantly and prominently mentioned in those works; and it is less new to scientific men, all of whom have long been familiar with the idea of forces being "modes of motion." The phrase is not, however, repeated in other parts of the book. We consider that had the words, *the modern philosophy of heat*, or *the modern philosophy of force as applied to heat*, been substituted for the words "a new philosophy," the real facts of the case would have been more accurately described. The author has, however, in this excellent book, made this view of the nature of heat more popular and more demonstrable, by illustrating it with many beautiful experiments of his own and of other investigators, some of which are new ones.

At page 2, the author says, "For by mastering the laws and relations of heat, we make clear to our minds the interdependence of natural forces generally." This statement, though perfectly true, and applicable to the science of heat, is equally true and applicable with regard to each of the physical forces; and indeed it is correct of knowledge in general that a perfect acquaintance with any one branch discloses to us the interdependence of all branches of knowledge upon each other, and the general principles of that natural dependence and connection.

The experiments of boiling water by heat of friction (page 13); of igniting a mixture of air and bi-sulphide of carbon by suddenly condensing it in a glass syringe (page 29); of melting fusible alloy by rotating it rapidly between the poles of a powerful electro-magnet (page 37); of the contraction of india-rubber by heat (page 88); and the rotation of metallic balls by means of a voltaic current (page 104); some of which appear to be of the author's own devising, are carefully described and admirably illustrated.

We were sorry to see (pages 128 to 131), under the headings "General Laws of Professor Forbes," and "Laws tested experimentally," the comparison again brought forward of the author's more accurate conclusions with the less accurate ones of Professor Forbes respecting the vibrations produced by the contact of bodies of different temperatures; because having once shown ("Philosophical Transactions of the Royal Society," Part I., 1854) that the conclusions arrived at by Professor Forbes were incorrect, and having republished the paper in full in the "Philosophical Magazine," July, 1854, and again in the form of a lecture at the Royal Institution, Jan. 27, 1854, it appeared unnecessary to repeat the results in that form; the accurate conclusions might have been described, and the refutation of Professor Forbes omitted.

In Lecture VIII. (page 248) and its appendix (page 270), is a clear and full description of that most interesting experiment, the causing a flame of hydrogen burning in a glass tube to emit a musical sound, by pitching the voice to it at a distance in a proper note, and also causing that sound to cease by similar means.

In various parts of his book the author largely employs mental imagery for the purpose of illustrating his views. He speaks of the swinging of atoms (page 250); clashing of atoms (page 51); friction of atoms against pure space (page 33); the electric current knocking against the atoms, and imparting its motion to them (page 212); the passage of atoms from state of freedom to a state of bondage (page 153); the falling of atoms down great precipices (pages 149, 150); &c., &c., as though he could actually see the atoms and distinctly follow their movements.

It is desirable, and even necessary, for the purposes of scientific investigation and discovery, to habituate the mind to a great variety of hypotheses, both abstract and otherwise, and to employ such images respecting the motions of atoms, &c. as *tools* in the daily work of scientific discovery; but we think such imagery, even though it be the most accordant with known facts, is not very suitable for conveying information, because of the great liability of unscientific persons to treat such conceptions as though they were real facts.

The book as a whole is beautifully written, and highly interesting on account of the number of good experiments contained in it. It is the most popular exposition of the dynamical theory of heat that has yet appeared. It contains the substance of the chief of the author's original investigations in the science of heat, particularly a valuable one on the action of gases upon radiant heat, which we have not space to criticise further than to observe that though not equal in degree of originality to the "Experimental Researches in Electricity" of his greatly talented predecessor, it represents a very large amount of labour, and manifests a high degree of accuracy in a very difficult subject.

Hints on the Formation of Local Museums. By the Treasurer of the Wimbledon Museum Committee. London: Hardwicke.

IT is every year becoming a question of greater importance how to find suitable employment for the increased intelligence of the working classes. Mr. Toynbee has solved the question in his own way: he says, the educated population of our parishes are surrounded by an inexhaustible profusion of objects adapted to improve and to gratify the understanding, and yet, for want of some plan of stimulating inquiry and observation, these treasures remain almost unknown. His little book, which is written in a thoroughly practical style, contains an account of a successful attempt to establish in Wimbledon a museum upon a plan which the author hopes may be found applicable to the formation of similar institutions throughout the country.

The feature which gives the present work an especial interest is its advocacy of purely local collections. On this point the author gives the views of Professor E. Forbes: "It is to the development of the provincial museums that I believe we must look in future for the extension of intellectual pursuits throughout the land." "When a naturalist goes from one country into another, his first inquiry is for local collections. He is anxious to see authentic and full cabinets of the productions of the regions he is visiting. He wishes, moreover, if possible, to study them apart, not mingled up with general or miscellaneous collections, but distinctly arranged with special reference to the region they illustrate. In almost every town of any size or consequence he finds a public museum; but how often does he find any part of that museum devoted to the illustration of the productions of the district? The very feature which, of all others, would give interest and value to the collections, which would render it most useful for teaching purposes, has, in most instances, been omitted, or so treated as to be altogether useless."

The Wimbledon committee seem to have resolved that this charge should not apply to them: their museum is designated to "consist solely of such objects of interest characteristic of Wimbledon and its neighbourhood as may be found within a radius of five miles from the parish church;" and though the district is an ordinary one, the committee are encouraged by being reminded that "the end of a local museum is not the exhibition of rare and so-called curious objects; but to develope and foster in the minds of all classes of people an interest in the common objects of nature which surround them." On the willingness of the labouring classes to avail themselves of such opportunities as may be given them for the study of natural history, the present work contains some interesting and gratifying remarks. The author, "when busy among and intimate with many of the poor of London, distributed to several families small Wardian cases, and though of a very humble character doubtless to the benevolent mind of their inventor, not unacceptably still retaining his name. These Wardian cases consisted of an old soup-plate containing some mould, a few sprigs of lycopodium, or small ferns, and a bell-glass about six inches broad and eight high. In these glasses the poor were supplied with a constant view all the year round of the purest green leaves and the graceful forms of the slender stems bearing them. He (the author) will not soon forget the delight with which these presents were received, especially by the sick and bed-ridden, how affectionately they were watched, how they formed the subject of pleasant conversation time after time, and how some were to be seen carefully guarded after ten years' gratification had been derived from them. The price of these cases was about one shilling each."

Many suggestions are given to facilitate the establishment and arrangement of local museums. The author recommends, as a preliminary measure, the holding of a "chat-meeting," which he thus describes: "A chat-meeting is a simplification of a *soirée* or a *conversazione*. It originated in the idea that many parishioners having in their homes interesting objects, the examination of which would afford pleasure and instruction to their fellow-parishioners, would on certain occasions gladly take these objects to a room appointed for the purpose, and display and explain them. Suppose half a dozen parishioners to bring objects on a certain evening, each parishioner taking a table, and in a quiet chatty way showing and describing to his brother parishioners the objects; one exhibitor would not interfere with another, and several pleasant chats might go on at the same time at different tables: this constitutes a chat-meeting, and with ordinary care and scarcely any trouble, a chat-meeting may be made very agreeable, entertaining, and useful."

The work concludes with a description of the apparatus needed for the collection and examination of natural objects, and a classified list of the more useful and recent works on the animal, vegetable, and mineral kingdoms.

We have seldom read a book more exclusively directed to a single good purpose than the present. No display of learning is made, no favourite theory is upheld; objections are answered and suggestions made, all in the simplest possible way; the author's name has to be incidentally made out by a reference to a list of the committee: not to gain applause, but to be useful, is evidently his aim, and we need hardly say that we heartily wish him success.

North Yorkshire; Studies of its Botany, Geology, Climate, and Physical Geography. By John Gilbert Baker. Longmans. 1863. 8vo., pp. 353.

THIS is the most philosophical attempt at a local flora which has yet been produced; a really noteworthy work, which, although treating largely of geology and kindred topics, must be regarded essentially as a botanical book. It is in nowise a popular treatise, nor is it abstruse, yet thoroughly scientific; the author being an original observer, who is content to write objectively, simply recording his facts in logical sequence, leaving the reader to make his own inferences. Hence the several sections are so far complete in themselves, that their consecutive dependance is by no means clear at a glance; the young geologist and botanist, the scientific tourist, local resident, and biological philosopher might each suppose the book made for his special use. Altogether it is well done.

The work is divided into three parts; in the first of which the geology, climate, and soils are treated with a view to their influence on the flora; in the second part are given the physical geography and topography, showing the localities and conditions under which the rarer plants occur; and, lastly, the botany, in which the flora is given in its relations to all these preceding circumstances.

As the studies on which it is founded have for the most part been made in the field, it is rather a book for out-door use and subsequent reference than one of those tourists' guides which beguile the hours of travel.

The chapter on geology is illustrated with a capital geological map, coloured to show all the important stratigraphical divisions. But the text confines itself to describing the physical features—subdivisions of strata, their thicknesses and trimmings out, appearance in the country, quarries and places where well seen—omitting all reference to the fossils and theoretical parts of the science.

The climatology also has a coloured map, showing the zones of altitude into which the Riding may be divided, which become the more interesting as corresponding for the most part with the limits of geological formations. The text gives abundant information on the zones, temperature, rainfall, winds, &c., with some account of the influences of these on cultivation and the indigenous flora.

The chapter on soils also has a coloured map, indicating the hardness and power of absorbing moisture of the different parts of the district, outlines which, as might be expected, correspond with those of geological deposits. These conditions necessarily affect climate and physical geography, and are indispensable to understanding the distribution of the flora.

The second part of the book is illustrated with a map coloured to show the districts drained by the several rivers. Here the author conducts the tourist about from dale to dale, pointing out the beauties of the scenery, its geological aspects, shows where rare plants may be gathered, and gives us their names; reminds us now and then of what has been sung by Wordsworth and Scott ; and is altogether a pleasant and valuable companion.

The third part, on botany proper, is prefaced by a summary of conditions affecting a flora ; and then follows a catalogue of the species. Here the author indicates in which of the drainage districts his plant is found, its range in height, the conditions under which it occurs, and the localities where it may be met with.

And, finally, there is an appendix giving an account of all the books, papers, and herbaria relating to the North Yorkshire flora, and an index of localities, and another of the genera of plants.

With all this material so systematically arranged, it is impossible not to regret that the author has not himself given some outline of those conclusions to which it cannot but have led. We would fain have learnt what variations the plant growing on the mountain-top presents when compared with the same species from the vale. We would gladly have been told whether the plant growing on clay was distinguishable from the same species inhabiting sandstone or limestone. We would have discovered what bearing all these external influencing conditions have on the flora, and what the significance of the limited range of a species may be. Perhaps Mr. Baker may yet be induced to give in some other form the results of his experience.

In conclusion, we can only urge all who go to North Yorkshire, and know the rudiments of botany or geology, to avail themselves thankfully of so luminous a guide as Mr. Baker.

MISCELLANEA.

SCIENCE ON THE CONTINENT.

Cultivation of Cotton in France.—The *Société d'Acclimatation* of Paris has for some time been engaged in encouraging the experiment of growing cotton in France, and the results now reported are certainly deserving of great attention. The Marquis de Tournes writes to the society that he is convinced that the cotton-plant may easily be acclimatized on the alluvial plains of Provence. "In spite of detestable weather," he says, "our crop surpasses that of last year; samples have been submitted to Messrs. Schlumberger, of Guebwiller, who report that, allowance being made for ginning, our long staple cotton may be set down as worth ten francs per kilogramme [about 3s. 8d. per lb.], and our short staple at six francs and a half [2s. 4d. per lb.]!"

The *Sériciculture Practique*, published in the Vaucluse, says: "The 150 kilogrammes of seed received by the Society of Agriculture has not been sufficient to supply the demands of cultivators, and a further supply has been sent from Algeria, with valuable hints as to the modes of cultivation."

In the neighbourhood of Avignon the experiment is being carried out with energy by the Agricultural Society and many private individuals.

The results above given certainly surpass all expectation, and it will be an equally curious and important result if the difficulties in America should give rise to the practical cultivation of cotton in the south of France. There remains, however, the grand question of the cost of production; and it will be strange indeed should it turn out that France can compete successfully with India, Egypt, and her own settlements in Algeria.

It is well to mention, in connection with this subject, that M. Louis Reybaud, who was commissioned by the Academy of Moral and Political Science to report on the condition of the textile manufactures, arrives at the conclusion that it will not be safe to depend on cotton in future, and that the only safe course will be to use all possible efforts to replace it, to a large extent, by flax and wool!

The Manufacture of Steel.—M. Caron has communicated to the Academy of Sciences of Paris the result of a series of important experiments made with the view to ascertain the part actually played by manganese in the fabrication of steel, and the results are given in a few words:—First, that the phosphorus of the iron is not carried off by the manganese; second, that sulphur, even without refining, will disappear in presence of manganese; and, third, that silica is in a great part removed by the manganese. These conclusions, says M. Caron, are confirmed by practice, for the minerals which yield the best steel frequently contain sulphur, but never phosphorus; and moreover it is remarkable that, although they contain coppery pyrites, the iron derived from them never contains sulphur. Manganese has, beyond question, the effect of rendering steel better and, above all, more durable; and this power is not difficult of explanation. When a sufficient quantity of manganese is added to grey cast-iron, of which the carbon is principally in a free condition, the result is white iron, in which the carbon is almost entirely in a state of combination. The effect is the same in the case of steel: a very small quantity of manganese is sufficient to retain the carbon in a state of combination, and to give to the metal those conditions which characterize steel of good quality. But the steel should never contain more than one two-hundredth part of its own weight of manganese, otherwise it becomes hard and brittle, the fracture assumes a crystalline appearance, and the metal loses a great part of its tenacity. Manganese has, moreover, the property of rendering steel capable of being welded, which is not so without its aid. It is not uncommon, in order to improve the quality of iron, to mix ordinary and manganesian iron together, and then to refine the mixture; and M. Caron says that he has learnt by experience that the purifying power of the manganesian iron is in direct proportion to the amount of the manganese present. It is therefore most important, he adds, to reduce the manganesian ores in such a manner as to retain the largest possible quantity of manganese in the iron. The spathic iron ore of Siegen contains 15 to 20 parts of manganese to 100 of iron, and yet the cast-iron derived from this mineral only contains from 6 to 7 per cent. of manganese; but if, by a modification of the furnaces, or a change in the nature or proportions of the fluxes, the amount of the manganese in the iron could be raised to 10 per cent., it is certain that cast-iron of very great commercial value would be the result.*

M. Caron promises further communications on this very important subject in a short time.

PRESERVATION OF WOOD.—Considerable attention has been given of late to this important subject in France and Belgium, and M. Pottier, of the University of Ghent, has recently presented a memoir on the effect of the creosote process to the Royal Academy of Belgium. He therein details his experiments with the heavy oil of gas-tar, and arrives at the conclusion that of the various ingredients which enter into its composition, the volatile hydrocarbons, aniline, phenic acid, and napthaline possess no preservative qualities whatever; and that the green oil which is produced by the distillation of gas-tar at a temperature of about 570° is that which is most effective in preventing the destruction of wood.

M. Lapparent, Director of Naval Construction in France, has been engaged in investigating the subject from another point of view. Having been impressed with the effect of the old method of charring posts and other timber to be fixed in the ground, he made a series of experiments on the causes of the destruction of timber and the action of carbonization as a preventive; and arrived at the conclusion that the practice alluded to contained the elements of a very valuable means of preservation. M. Lapparent believes that the effect may be produced without any material destruction of the wood, and that all that is required is a very thin coating or deposit of empyreumatic products, or, in other words, that the necessary carbonization may be obtained without any alteration of the surface of the wood, or any diminution of the sharpness of the angles. He makes use of a jet of gas, mingled with a current of compressed air, in order at once to produce a more active combustion, and to give a more decided direction to the flame. It matters not what gas is used so that it give a great heat in burning. When the pieces of wood to be carbonized are small or light, they are passed over the flame of gas by hand, but in dealing with heavy timber, or with pieces fixed in position—such, for instance, as those of a ship upon the stocks—the heat is applied by means of a nozzle in connection with two elastic tubes, one supplying gas and the other atmospheric air under pressure. M. Lapparent says that specimens of wood of various kinds thus prepared have been placed in a dunghill side by side with unprepared pieces of the same timber, and that at the end of six months decay had attacked the latter in a decided manner, while the former remained perfectly untouched.

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* See also Summary of Metallurgy.

This process is particularly recommended in the case of hard woods, which can with difficulty be impregnated with those antiseptic substances which are so effective with timber of the softer kinds. Wood prepared by M. Lapparent's process is being submitted to trial in the Imperial dockyards of France, and also by the railway companies; and it is contemplated to apply it also to carpentry and cabinet-making. We are also informed that similar trials are being made in the English dockyards.

IMPERFECTION OF LIGHTNING CONDUCTORS.—The attention of the French Academy of Sciences has been drawn by M. Perrot to the important question of the inefficiency of the conductors in general use. Three propositions, derived from a number of experiments, are laid down by M. Perrot:—1st, that the surface of the conductor in contact with the water of the soil is generally so insufficient for the rapid dissemination of the electric current, that the conductor cannot be struck with lightning without becoming itself dangerous to the objects in communication with it; 2ndly, that the ordinary conductor is, however, sufficient to give passage to a constant current of electricity sufficient to neutralize that of an approaching storm; and, 3rdly, that in order to arm the common conductor against danger from thunderstorms, the rods should be furnished with a number of long, thin, divergent points of a high-conducting material. The experiments of MM. Pouillet and E. Becquerel have shown that pure water conducts electricity 6,754 millions of times less than copper, and M. Perrot therefore concludes that the surface of water in contact with the conductor should be that number of times at least more extensive than that of the copper. If, therefore, he says, the section of the conductor be equal to one square centimètre, the surface in contact with the water should be equal to 675,400 square mètres, whereas it rarely amounts to more than the tenth of a square mètre. The submerged surface of the conductor is therefore generally about ten thousand times less than it should be, and presents ten thousand times more resistance to the electric fluid than the other portions of the rod itself, so that when such a conductor is struck it presents a resistance in proportion, and becomes dangerous to surrounding bodies.

The following instructive experiments have been made in support of these deductions:—One end of a rod, representing a lightning-conductor, having been placed at explosive distance from the conductor of an electric machine in communication with a Leyden jar, the other end was plunged into water contained in a metallic vessel in communication with the exterior of the jar and with the earth, the rod itself being isolated in order that one electric current should not neutralize the other without passing through the water. The machine having been set in action, the electricity, instead of traversing the water without flash or noise, presented itself on the surface in the form of a brilliant star, the rays of which stood out from the submerged conductor often to three times the length of the spark of the machine. "In order," says M. Perrot, "to test the electric tension at various parts of the conducting-wire, and consequently the danger to surrounding objects from an ordinary lightning-conductor, I applied a metallic sphere, and found that it was struck at distances varying from a fourth to a third of the length of the spark from the machine."

It is impossible to overlook the practical importance of these experiments and deductions, which demand careful examination by electricians.

THE SARBONNE.—Some few weeks since the learned world was considerably interested, and some of its members rather scandalized, by the fact of a young lady being admitted to academical honours. The other day another curious incident occurred within those ancient walls, where the Admirable Crichton carried off so many laurels in competition with the most brilliant scholars of his day. A young man born deaf and dumb having been received as a bachelor in the literary section, the examination was conducted in writing, the proficiency of the candidate being thoroughly established. This gentleman is the second son of the Comtèsse de Chastellux, daughter of the Duchess de Rantzan, and one of four brothers, three of whom are deaf and dumb.

THE ACADEMY OF SCIENCES has elected Admiral Fitzroy a corresponding member in the section of geography and navigation, in the place of the late Admiral Sir James Clark Ross.

ENGLISH STEAM-ENGINES FOR THE FRENCH NAVY.—A considerable number of eminent engineers and other scientific men, French and English in Paris, were invited a week or two since to see a beautiful working model of a pair of screw engines now being manufactured for the French man-of-war *Vienne*, building at Toulon. These engines were ordered by the Emperor of Messrs. Jack & Co., of Liverpool, and of the same pattern as those supplied by that firm to many mercantile steamers, but not yet, as we believe, introduced into the British Navy. The two great objects in view in Messrs. Jack's arrangement are direct action upon the screw shaft and economy of fuel. The cylinders are on the Woolf principle of high pressure and expansion combined. The chief peculiarity, however, is the arrangement of the condensers, which are on the principle known as surface condensation,—that is, the steam to be condensed passes through a long and tortuous series of tubes, which are refrigerated by a constant flow of cold sea-water made to circulate by pumps worked by the engine; the great object of surface condensation being to leave the condensed steam free of any intermixture with the salt-water. The mechanical arrangement adopted by Messrs. Jack & Co. is curious. The framing of the engines is entirely tubular, and the condensers occupy the spaces between the plates that form the walls of the frames; this affords space within the latter for an immense extension of condensing tubes, and also for the use of a proportionately large quantity of sea-water as a refrigerant. Another feature is the "feed-water heater," by means of which the exhaust steam is made to part with its heat to the condensed steam which feeds the boiler, entering the latter at a high temperature. We need not inform our practical readers that the great problem of the day in marine engineering is the economy of fuel, and the consequent increase of the distance that a steam-vessel can run without coaling, and Messrs. Jack & Co. seem to have achieved an important step in that direction. The working of the model was admirably explained by a gentleman connected with Messrs. Jack & Co.'s establishment, and seemed to give great satisfaction. Some surprise was expressed that the Imperial Government should have preceded the English Admiralty in putting to a practical test the asserted advantages of this form of engines for screw men-of-war; but British inventors and manufacturers know too well that private firms are held in little honour in their own country, or at any rate by their own Government. Y.

PARIS, *June*, 1863.

FALSE MOONS, OR PARASELENÆ.

As the occurrence of paraselenæ, or false moons, is rare in these latitudes, I send a short account of the appearances which presented themselves to the inhabitants of this small town and its neighbourhood on the night of May 29th, 1863. I find no mention of the phenomenon in the local papers of this day (June 6th), or in the London papers of the week past, and imagine therefore that it was seen by comparatively few. The day had been hot, with a W.N.W. wind bearing dark, heavy masses of cumulus. In the evening the moon was bright, but slightly veiled by a thin layer of misty cloud. At about 9.40 p.m. two false moons of great brilliancy appeared east and west of the true moon; they showed prismatic colours, and each was adorned with a comet-like tail stretching outwards. They were united by a circular halo of about 40° diameter, the upper arc of which was very distinct and beautiful. At about eleven o'clock a smaller halo very finely coloured encircled the moon; it had a diameter about three times that of the moon itself. These interesting phenomena continued visible with varying brilliancy until midnight.

I send a diagram of these appearances to help out my faulty description.

THOMAS EDWD. AMYOT.

DISS, NORFOLK, *June 6th*, 1863.

PROVINCIAL INSTITUTIONS AND SOCIETIES.

MIDLAND SCIENTIFIC ASSOCIATION.

The report of the proceedings of this society has reached us too late to admit of a lengthy notice. On the 8th April a meeting was held at Bank House, Burton-on-Trent, when the following papers were read by members :—

"On the Benefits and Injuries to Agriculture by Small Birds," by Mr. Edwin Brown. The author advocated the exterminating work of sparrow clubs; these birds being, according to his views, very prejudicial to agriculture. Great difference of opinion prevailed on the subject amongst the members, some of whom supported whilst others opposed the views of Mr. Brown.

The Secretary then read a paper contributed by the Rev. W. Coleman, "On the Indications of Combustion prior to the Glacial Epoch, in a Bed of Coal near to its Outcrop," and afterwards exhibited a specimen of coal containing ramifying veins of galena, or lead ore, found in a disused colliery in Leicestershire.

Mr. Knobel next read a paper "On the Occurrence of Native Metals."

Then followed an address by Mr. Edwin Brown, "On the Possible Effects on Vital Phenomena of Tea when used as a National Beverage." The author believes that the use of tea is calculated to lower the vital energy of the consumer, and that possibly in the course of time a large use of tea may reduce us "to the physical stamina of the Chinese."

After one or two remarks from medical men,

Sir Christopher R. Lighton jocularly expressed the hope that Mr. Brown had not been bribed by the brewers of Burton to bring on the subject.

"The general opinion of the meeting appeared to be that tea enables the mental worker to perform his task with greater ease, but that used as the sole beverage it has a lowering effect ultimately upon the human frame."

Thus ends the report. Did the discussion take place before or after a repast? And to what beverage were the members obliged to resort in consequence of Mr. Brown's paper?

THE WARRINGTON FIELD NATURALISTS' CLUB.

This society, which was inaugurated in the spring of 1862, under the presidency of T. Glazebrook Rylands, Esq., F.L.S., held its first anniversary meeting on the 8th of April. The proceedings were rendered exceedingly interesting by the exhibition of geological, botanical, and other specimens, including some of great rarity and interest. The geological department was under the care of Mr. Paterson, manager of the gas works, who kindly lent a series of valuable fossils, chiefly from the Carboniferous formation of the North of England. Tables were also set apart for plants, both native and exotic; and several microscopes, belonging to members and others interested in the society, revealed some of the beauties of the infusorial world.

The president delivered a very interesting address, in the course of which he set forth the advantages—especially to working men—of cultivating a taste for the study of nature, and gave instances of men who, after beginning life in a very humble way, had attained considerable eminence in the scientific world.

Mr. Peers, the secretary of the society, read the report for the past year, from which it appeared that forty-four ordinary meetings had been held. There were twenty-eight members on the books,—twenty-five ordinary and three honorary. The herbarium of the society contained about three hundred and sixty species of British plants, the greatest portion of them gathered in the neighbourhood by members during the past year. The thanks of the society were accorded to the Rev. R. Rolleston for gifts of specimens of plants, both fresh and dried; to Robert Davies, Esq., and Alexander Irvine, Esq. (editor of the *Phytologist*), for specimens of dried plants; to William Wilson, Esq., for several specimens, amongst which were *Potamogeton lanceolatus* and *Carex divisa*, which, coming from that source, must be considered authentic; and to the Mechanics' Institution for the use of a room for meetings. The expenses of the Society had been trifling, and the terms of membership were fixed at the lowest possible figure.

The report having been adopted, Mr. Peers read a paper on the botany of the district, illustrating it by means of dried and fresh specimens, especially pointing out the most important natural orders represented in the neighbourhood.

Mr. Cash (treasurer to the society) read a paper on "Microscopic Life in the Neighbourhood of Warrington," in the course of which he referred to examples of the more important Rotifera, Protozoa, and Protophyta, which had come under his observation. He exhibited living specimens of the rare and beautiful *Stephanoceros Eichhornii*, and several other interesting creatures; and mentioned, as common in the district, *Melicerta ringens Floscularia ornata*, and several others.

Mr. Green read an interesting paper, the object of which was to show the pleasure to be derived from a study of the works of nature. After which, Mr. Paterson, at the request of the president, made some remarks explanatory of the fossils which he had been kind enough to bring.

Mr. Cooper (curator of the Warrington Museum) afterwards read a paper on the subject of Entomology, the claims of which he warmly advocated.

At the conclusion, a cordial vote of thanks was passed to Mr. Rylands for presiding, on the motion of the Mayor of Warrington (James Shepherd, Esq.)

ROTHERHAM LITERARY AND SCIENTIFIC SOCIETY.

The town of Rotherham and the adjoining parish of Masbro' have been, until recently, deprived of the benefits of a literary and scientific society;

but the enterprise of a few intelligent men has filled up the void, and on Monday, the 12th January last, the Rotherham Literary and Scientific Society was inaugurated in the Lecture Room of the Mechanics' Institute, with an able address from the Rev. H. Master White, one of the Vice-Presidents of the new society.

This gentleman, along with Mr. Percy Smith, Mr. Beale, Mr. Haywood, the "Greave of the Feoffees" (the leading functionary in Rotherham), and a few others, had been at work some time previously, as a provisional committee for drawing up rules and obtaining subscribers; and they had succeeded in enlisting the support of most of the friends of literature and science in Rotherham and its vicinity.

The opening address was upon "Literary and Scientific Societies," in the course of which the lecturer ably reviewed the history of these societies from the earliest ages. In Ancient Greece, he said, there were, strictly speaking, no literary societies; the followers of the various philosophers met rather as pupils than as equal members of a society. The Roman law was jealous of all voluntary associations. After touching upon the monastic institutions, and expatiating upon their value in the preservation of learning through the dark ages, the lecturer stated that the first "Literary Society," in our sense of the term, was founded about the year 1572, by Archbishop Parker; that it flourished during the reign of Queen Elizabeth, but was suppressed by James I. About the year 1718, however, its meetings were resumed at a tavern in London; but in 1750 it obtained a Royal Charter, and was placed on a firm footing.

After giving a sketch of the origin and growth of the Royal Society, and illustrating from its earlier papers the ignorance which generally prevailed in the 17th century, Mr. White said that two principles had led to the formation of most "Scientific Societies." One was that, as the field of knowledge had been enlarged, it had been found impossible for single individuals to explore more than a small part of it thoroughly. Societies were therefore required, composed of the workers in special subjects. Such societies were the Botanical, Zoological, &c. The other was that the connection of the various parts of the natural world became more striking as the more abstruse laws of each were discovered. Societies were, therefore, wanted to bring together the students of different branches. Such a society was the "British Association for the Advancement of Science." But while he had been speaking of "Literary Societies" and "Scientific Societies," he said nothing of those which, like their own, professed to be both literary and scientific. He trusted, however, that he had said enough to show the boundless field before them, and the way in which even humble contributions may be serviceable to the general store.

Having concluded his review of kindred societies, the lecturer referred to the social and moral benefits to be expected from the one they were met to inaugurate; and at the conclusion of his address, one of the Secretaries. Mr. Percy Smith, announced the mode in which the proceedings of the Society are to be conducted. There will be monthly Lectures, to be delivered by private individuals residing in the town, which will be followed by discussions; and occasional paid lecturers will be engaged to deliver courses of lectures on literary and scientific subjects. The Secretary encouraged the members of the Society to throw off that reserve which usually stands in the way of free discussion, and not to dread the results of what he humorously characterized as pugilistic sparring with their master, in the Science. He then called upon Mr. James Samuelson, of Liverpool, (who was present by invitation), to take part in the proceedings.

Mr. Samuelson, after expressing his wishes for the success of the Institution, drew the attention of its members to the movement which is now taking place for the popularization of Science in Great Britain, as exemplified in the Naturalists' Field Clubs and Science Classes daily springing into existence, and warmly recommended the founding of these in connection with the new Society. Having referred to their success in other towns, he said that he felt sure they would be attended with great benefit in the heart of so large a manufacturing district as that in which they were assembled.

An animated discussion followed.

Mr. George Haywood (Greave of the Feoffees) gave some account of the progress of the Rotherham Mechanics' Institute, and said that their great difficulty lay, not in obtaining pupils, but teachers. He thought this difficulty would be removed by the remuneration given by Government to teachers of the "Science Classes" mentioned by Mr. Samuelson.

Mr. Beale, the second Honorary Secretary, stated that the "Penny Lectures," at the Midland Institute, in Birmingham, to which reference had been made, owed their success to the practical nature of the subjects on which Lectures were delivered; and he recommended that the same course should be adopted at Rotherham.

Several other members followed: and the first Lecture and subsequent discussion certainly gave great promise of an energetic movement in the right direction, inaugurated by the Rotherham Literary and Scientific Institute.

THE WEST KENT NATURAL HISTORY AND MICROSCOPICAL SOCIETY.

This society reckons amongst its members some of the leading men of science in England. Its president is Frederick Currey, Esq., F.R.S. (one of the editors of the *Natural History Review*), and in the list of its committee and members we find the names of Mr. Glaisher, F.R.S., Professor Bell, Professor Morris, Rev. J. G. Wood, and others of known repute. The Report of the past year is highly satisfactory: the funds of the society are flourishing, the members (113) on the increase, and the meetings interesting and diversified. The excursions are not frequent, there having been only one during the whole of last summer. The *soirées* are well attended, and rendered interesting by the exhibition of microscopes, of which more than fifty were contributed on one occasion. The most interesting feature in the last year's proceedings of the society was a paper read in October by James Glaisher, Esq., one of the vice-presidents, on which occasion a very crowded meeting, at which many ladies were present, listened to him with much pleasure as he detailed the particulars of his late balloon ascents, made at the suggestion of the British Association, and conveyed to his hearers, in a pleasing and popular form, and by the aid of excellent diagrams, the scientific results obtained by his aërial voyages. In addition to its gatherings, the society is employed in the collection of microscopical specimens, for which a cabinet has been purchased; and we would direct the attention of dwellers in seaports to the fact that this society is collecting, and solicits contributions of deep-sea soundings, especially of such as contain Foraminifera.

We are a little puzzled to discover where are the head-quarters of this society. We presume in Greenwich, where the Report is printed; but as the President lives in Blackheath Park, and the Secretaries at Lewisham, it would be well if some hint were given to intending subscribers concerning its *locus in quo*. West Kent is a large place!

MANCHESTER FIELD NATURALISTS' SOCIETY.

The report of this society for 1863 shows that it is daily extending its sphere of usefulness. Its excursions and soirées have been fruitful in results; and the most interesting feature in its transactions appears to be Mr. Holland's address on poisonous plants.

The specimens collected to illustrate the lecture comprised the following (with others of less importance), and those from which any danger was apprehended to the audience were enclosed in glass cases:—

LIVING PLANTS.—*Helleborus fœtidus*, *Aconitum Napellus*, *Daphne Mezereum*, *Digitalis purpurea*, *Cicuta virosa*, *Mercurialis perennis*, *Buxus sempervirens*, *Colchicum autumnale*, *Arum maculatum*, &c.

DRIED PLANTS.—*Chelidonium majus*, *Hyoscyamus niger*, *Atropa Belladonna*, *Œnanthe crocata*, *Conium maculatum*, *Veratrum album*, &c.

PRODUCTS AND PREPARATIONS.—Opium, morphia, bitter-almonds hydrocyanic acid, nux vomica seeds, strychnine, and various other seeds and poisonous alkaloids.

Mr. Grindon, the secretary, also delivered a very able lecture on the "Prefigurations of Nature," in which he showed that external nature everywhere abounds in objects which prefigure other higher ones; and he selected his illustrations from the inorganic as well as the organic world. His lecture did not deal with the theory of development; but tended to show that all nature is founded upon one great plan, and that *man* is the "summary and synthesis of all other natural objects."

We are glad to observe that prizes are now granted by this club to the ladies who make the best collections of plants of various kinds at each excursion.

DUDLEY AND MIDLAND GEOLOGICAL AND SCIENTIFIC SOCIETY AND FIELD CLUB.

THIS flourishing society was established last year, on the foundation of a former geological society which once existed in that neighbourhood, but which, under a somewhat too rigid mode of management, had not in it very much vitality. The new society seeks to combine the main features of a field club, archæological association, practical miners' society, and general scientific body, and has hitherto met with an amount of support and success that augurs well for its future prosperity. It has now nearly 400 members on its lists, it is affiliated with all the leading scientific societies in the midland counties, some of the most eminent names in geological science are among its corresponding members, and many of the papers which have been read at its meetings are remarkable for their practical utility. No less than eight field meetings have been held, for the purpose of examining the interesting geological and scientific features of the district; and several evening meetings have also been held, when fossils and scientific apparatus have been exhibited, and papers have been read and discussed. The annual meeting was held on the Wednesday and Thursday in Witsun week, and was most numerously attended, not only by scientific men from the surrounding district, but also by many well-known gentlemen from London and other places. The proceedings included excursions through the limestone workings at the Wren's Nest Hill, and through the famous Silurian caverns of the Castle Hill, which were brilliantly illuminated for the occasion by the Earl of Dudley. Some idea of the extent of these excavations may be formed from the fact that upwards of 3,000 candles, exclusive of lamps and coloured fires, were used in the illumination. Mr. J. W. Salter delivered an address in the largest cavern, and at an earlier part of the day Mr. S. H. Blackwell read the annual address (which was an elaborate *résumé* of the progress of geological science for the last twenty years), and Professor Tennant gave a lecture on "The Connection between Mineralogy and Geology." In the evening Mr. Blackwell showed some splendid experiments on the combustion of iron on a large scale. The following day the party went to inspect one of the Earl of Dudley's coal-pits near Dudley; and here again the Earl, with his accustomed liberality, caused the whole of the workings to be illuminated. Several hours were spent in examining the peculiarities discovered in the mining operations, especially with reference to the intrusive basalt and greenstone in one part of the pit. The whole of the two days' varied proceedings were extremely successful. We notice that field days are arranged for Malvern, South-Western Shropshire, Wenlock, and Matlock, and arrangements are in progress by which more practical importance may be given to the society's operations. We shall be glad to record the progress of the society, and to witness its development.

SOCIETY OF AMATEUR BOTANISTS.

Metropolitan Club (Library), 239, Euston Road.

This "Field Naturalists' Club," recently established in London, is one of a high order, and deserves the encouragement, not only of those who desire directly to participate in its advantages, but of all who are interested in the advancement of Science.

It is one of those Institutions the establishment of which, in some new locality, we have to record in each succeeding Number. An Excursion Club; an Association for the interchange of specimens; reading of Botanical papers; and for the establishment of a local Museum, Library, and Herbarium.

The subscription fee is 2s. 6d. per annum. The indoor meetings will be held fortnightly, in addition to the outdoor excursions. The system of granting prizes to successful collectors will be adopted by this Society; and the first prize, offered for competition by the President, Mr. M. C. Cooke, is "Berkeley's British Mosses."

We hope that those amongst our metropolitan readers who are anxious to promote the spread of botanical knowledge will give their support to this Society, which is established for the special study of this branch of science.

FRENCH WORKMEN ON THE LONDON EXHIBITION AND ENGLISH MANUFACTURES AND WORKMEN.

BY G. W. YAPP (PARIS).

THE commission of French ouvriers appointed to examine and report on the products of various countries to be seen at the International Exhibition, and to inquire into the manufactures pursued in our own country, has just commenced the publication of its reports. They are short, pithy documents, the longest of them only occupying thirty odd pages of small size.

It is not at all surprising that the tone of these reports is very different from that of many which have appeared on the late and other Great Exhibitions: the French workmen had a deep interest in their labour; they set about it in a plain, straightforward, and practical spirit—very different from that dainty *dilettante* manner which unfortunately characterizes many documents on such subjects, and which makes them unacceptable to practical men. The delegated workmen knew well the weak points in their own case, and of course measured English products and English workmen by their own standard and by the light of their own grievances.

The series of reports which will record the impressions made on the minds of men, selected by their fellow workmen in each class of industry at home, not only by the products seen in the Exhibition at South Kensington, but by an examination of factories and workshops of London, and by visits to the homes of our own industrious producers, cannot fail to be deeply interesting to all classes of enlightened and practical Englishmen; nor will the effect produced in the minds of the reporters by their reception here, be without interest for all who desire to see the prejudices swept away and the grand industrial contest pursued boldly but generously between us and our rivals.

1. *Report of the Tanners, Curriers, and Morocco Leather Workers.*—This and other reports are preceded by a short historical notice, after which the ouvriers give the general result of their observations in a few paragraphs. They say they are convinced that, on the whole, France excels her rivals in the preparation of leather and skins, and that although England, Germany, and Switzerland are superior on certain points, the French manufacturers have nothing to fear, and that the materials and processes employed in England are inferior to those of France. At the same time

they warn their countrymen that they must not sleep, for that they may then be overtaken, or even surpassed by the English, who are ever on the search after improvement, and who act with intrepidity and disregard of expense in order to dispute with their rivals the first position in foreign markets. The reporters then remark in detail, but briefly, on the whole of the productions in their class shown at the Exhibition. We cannot follow them through these special notes; suffice it to say that our Moroccos are well spoken of, that English calf leather is generally condemned as wanting in suppleness, that our sole-leather is accused of sponginess, that our dressed pig-skins for saddles and other purposes are declared to be perfection in their way, and that some of our bookbinder's calf is highly lauded.

Finally, the reporters give an account of what they saw of the London factories, and of the impression made in their minds by a comparison of their own condition with that of English workmen in their own class; and we are sorry to find from the report that the delegates were so ill-satisfied with the reception afforded them by the master tanners and leather-dressers, that they express a hope that any future commission may have better opportunities. The reporters are of opinion that France excels in the fundamental part of the leather-dressing, namely, tanning—both as regards material and manipulation; and they express an opinion that the universal tendency of the English to substitute machinery for hand labour may contribute to their inferiority in this respect. It is admitted, however, that some firms in London approach nearer than those of any other country to the French standard, and that in the preparation of pig-skins we stand unrivalled—a superiority which is curiously attributed "solely to the care which our neighbours exhibit towards the porcine race," as if poor piggy's education involved the first principles of tanning his hide.

But the remarkable portion of these reports is the positive evidence of the superior position of the English as compared with the French workman. "Certainly," say the reporters, "we could not expect that in this comparison France would take the first place." On the contrary, the report declares that, "during the last forty years, the causes of complaint have grown like the snowball," and that "no one can expect French workmen to glorify their present position." Again—"France no longer ranks in the first class of nations in the eyes of those who see the miserable pay she gives her children, her workmen of all classes, whether industrial or agricultural."

The French workmen naturally regard with great interest the freedom of combination and discussion enjoyed by Englishmen, and declare that employers in France act, in the matter of wages, in a narrow and arbitrary spirit. As regards the comparative rates of payment in the two countries, the following passage is too striking to be omitted:—

> "The wages paid in England since 1812 are, on an average, 30 per cent. higher than those received by French workmen, and in the case of waxed calf the English workman makes twice as much as his brother in France!"

This enormity, says the report, is in no way counterbalanced by the expense of living; for the delegates declare that they lived with English workmen for some time, that they had the best of opportunities of judging, and that they are convinced that the necessities of life are quite as cheap in London as in Paris.

2. *Report of Lithographers.*—The delegates in this trade complain that many of the works in the Exhibition were hung so high that it was quite impossible for any one to judge accurately of their execution. Some reproductions of works of art, in colours, from Munich, are spoken of in laudatory terms, as regards workmanship and cheapness, although the artistic ability is considered to be mediocre. As to the English lithographic copies of water-colour drawings, the report says :—"They exhibit a truthfulness and richness of execution of which we had no conception," and that "the great success they have achieved with the public is perfectly intelligible." The delegates were, however, astonished at the great number of stones used in the production of some of the more elaborate works, and declare that in France the co-operation of the artist and the ability of the printer would enable the French lithographers to dispense, in many cases, with one-third of the number. The English mode of drawing on the stone is described as peculiar, and as leaving nothing to be desired on the score of fineness and solidity. Another grand point of superiority in England is declared to be the paper, in which respect the French lithographers are said to be worse off than those of any other country in the world.

The English paper, says the report, is as supple and as well adapted to take up the colours, without injury to the stone, as ours is hard and unfitted for its work. In another place the paper in use in France is declared to possess no one good quality whatever but its whiteness.

In lithographs executed with crayons and tints on three or four stones, the French workmen claim superiority over both the English and Germans; and, as regards works in black and white, the reporters say that England has not yet, apparently, found lithographic artists of sufficient talent to stand against copper-plate engraving, which she holds in such high estimation; while the writing of English lithographers is spoken of with the highest admiration, the reporters declaring that the beauty of some of the specimens which they saw almost surpassed belief.

Like the tanners, the lithographers visited some of the London establishments, but, unlike the former, they speak in the highest terms of the courtesy with which they were received, and of the openness with which all the modes of operation were exhibited to them. "On the part of the workmen," says the report, "there was none of that obsequious curiosity which assails visitors in our ateliers; the well-behaved apprentices had none of the bantering effrontery of our own, but everywhere we were received with a gravity as cordial as temperament and the difference of language admitted."

The systems pursued by the publishers of England and France are contrasted entirely in favour of the former, that of the latter being denounced as narrow and parsimonious in the extreme, and as tending only to the production of cheap and bad work.

As to the condition of the working lithographer, the report says :—

"We found, as we indeed already knew, that for piece-work the English received *more than double* the sums paid in France; while for day-work the advantage is greatly in favour of the former. In France, the payment remains the same, insufficient, while the cost of living and food increases every day."

The liberty which the English workman enjoys, and which, says the report, he knows so well how to use for his own interest and improvement, naturally calls forth the admiration of the delegates, who say that none but the masters are allowed to combine in France, and that the consequence is the reduction of wages, the deterioration of the product, and the ruin of the trade. The French visitors found the English lithographers better lodged and better fed than those of France. Lastly, say the reporters:—

"The English are stronger than we are; they do not kill themselves at their work."

AUSTRALIAN EXPLORATION.

THE extension of our geographical knowledge forms one of the most interesting features of the present day, and the adventurous spirit for which the Anglo-Saxon race are so famous finds constant food in the fields of discovery which yet lie unexplored in distant and difficult regions of the globe, but which are by degrees being opened up by the indomitable perseverance and unflinching energy of brave and daring men. The discoveries of Livingstone, of Speke and Grant, and Petherick, are results of successful exploration by men who have been so fortunate as to achieve the end they contemplated, though they carried their lives in their hands in order to attain it; but the mind recurs with gloom to the sad fate of others not so fortunate, who, like the ill-fated Burke and Wills, overcome by the inhospitality of the regions they traversed, succumbed in the wilderness, and left their bones bleaching in the far interior of Australia. All honour to such men, to whom the sweet reward of a safe return to the abodes of civilized life, and the acclamations of their appreciating fellow-men have been denied—who have thus offered themselves as sacrifices to scientific investigation and a thirst for knowledge of the unknown.

From such a sad picture it is a relief to turn to the success which has lately crowned another attempt to cross the vast continent of Australia, and the return of Mr. Stuart's party to Adelaide. This explorer, it will be remembered, left Adelaide in the beginning of the year 1862 to complete the exploration which he commenced in 1859, and which for the second time he was unable to finish in 1860. On the first occasion he was turned back by hostile natives, and on the second occasion by a dense scrub which separated him from the Victoria River, after he had reached as near to the coast as latitude 17° and longitude 133°. In this third expedition, however, Mr. Stuart has been completely successful. After crossing to latitude 17°, upon his old route, he found in the course of a lengthened examination of the country, that the belt of scrub, which had seemed to hem him in hopelessly from the coast before, was penetrable in a northerly direction; and instead, therefore, of further seeking to reach the Victoria River, he pressed forward through Arnheim's Land, and came out upon the coast near Point Hotham, opposite Melville's Island. Thus there is now a direct route from Adelaide to Port Essington, and more than three parts of the country through which it runs has been traversed by Stuart and his party *six times*, this being the third consecutive year that his expeditions have crossed and recrossed this continent. From these facts it will be seen that the exploration is one of vast importance to all the Australian colonies. The journeys of previous explorers who have crossed the continent have terminated at the Gulf of Carpentaria, where the country is low and swampy, and where ships trading with India and China would meet with difficulties in navigation. But a route is now opened from South Australia to a point on the coast six degrees beyond the head of the Gulf, which was the place reached by Burke, and afterwards by McKinlay; and this route is found traversable during the driest of seasons.

The peculiar features of travel in the interior of Australia are well illustrated by a reference to Mr. Stuart's diary, which chronicles the movements of the party from day to day, the appearance of the country, and the natural productions met with, though these last are not described with any scientific accuracy. As far as Newcastle Water, in latitude 17° the route had been several times traversed, but from that point Mr. Stuart's journey was through a new country. Here he was in the middle of April, 1862, the weather very hot, strong winds often blowing during the day, and the falling of the wind at night being the signal for troops of mosquitoes and flies to appear, much to the annoyance of the travellers. With such hot weather he dared not attempt to make the Victoria River, for the horses would not stand a 140 miles' journey without water, the discovery of which was always precarious. Indeed it may be said that a journey of exploration across the continent of Australia resolves itself into a constant search after this indispensable necessary. Water-holes were occasionally met with, sometimes, however, dry, and sometimes merely the deeper parts of the beds of dried-up creeks, and rivers through which water flows during the rainy season. The appearance of a few birds from time to time, such as slate-coloured cockatoos, pigeons, &c., announced the proximity of water, and was therefore always a welcome omen. To add to the difficulty, it was soon discovered that their water-bags, on which their progress, and indeed their very lives, depended, were not by any means satisfactory. On the 8th of May it appeared that the water-bags in a journey of 21 miles had leaked out one half of their contents, and the same circumstance was a frequent source of annoyance and perplexity. It took two men nearly half a day to fill them, on account of the smallness of the orifices, and the American cloth with which they were lined not only did not render them water-tight, but allowed of the water getting between it and the leather, thus rendering the process of emptying them a matter of difficulty.

Mr. Stuart bears a very pleasing testimony to the devotion of his party; and his diary often records his approbation, which he frequently expressed by naming the various localities after one or other of his retinue. Few spots were of more importance to be specially designated than the water-holes and chains of ponds. Thus on the 2nd of May, the party arriving at a small water-course, with pools of water flowing into the plain, Mr. Stuart observes, "These ponds I name King's Ponds, in token of my approbation of his care and attention to the horses, and his readiness and care in executing all my orders." And this is no solitary instance: other springs were named in a similar manner, "Nash's Spring," "McGorerey's Ponds," "Auld's Chain of Ponds," "Frew's Water-hole," &c., &c., *in token of approbation.*

As might be expected in a country of such a nature, animal life is anything but abundant. Birds not unfrequently appeared in some numbers, but their kind is not always specified. In the neighbourhood of King's Ponds cockatoos were observed, and old tracks of the emu, but no quadruped game, except one wallaby and one kangaroo. The forest, it appears, grows dense and tangled, though no water be near, but in such situations not a bird was to be seen, nor the chirrup of any heard to disturb the gloomy silence. On Daly Waters, which cover a large area but are not deep, pelicans and other water-birds were observed; and the party here caught a number of small fish, from three to five inches long, something resembling a perch, which were looked upon as a godsend by men who had so long lived upon dry meat. In River Strangways, also, fine large fish were caught, some of them weighing 2½ lb. Of these some were of the perch family, and others resembled rock-cod, with three remarkable black spots on each side of their bodies. There were also some smaller ones resembling gold-fish, and other small ones, with black stripes on their sides, resembling pilot-fish.

The vegetable productions of the country vary according to the proximity to water. In a valley through which a stream of water runs, the sides are described as thickly wooded with tall stringy-bark, gums, and various kinds of palm-trees, which were very beautiful, the stems growing upwards of fifty feet high, and the leaves from eight to ten feet long, each side resembling an immense feather: a great number of these shooting out from the top of the high stems, and falling gracefully over, produced a very pretty, light, and elegant appearance. In other places dense scrub and impenetrable forest of gum-trees and tall mulgar, through which they in vain atttempted, by pushing, tearing, and winding, to make some progress, obliged them to make a circuitous journey. Such was that met with near Auld's chain of ponds. This, says Mr. Stuart, would be a fearful country for any one to be lost in, as there is nothing to guide them, and one cannot see more than 300 yards around. "Should any be so unfortunate as to be lost, it would be quite impossible to find them again; it would be imprudent to search for them, for by so doing the searchers would run the risk of being lost too." In such situations the usual resource of climbing a tree sometimes led to deceptive appearances of open country, caused by the shade of the sun on some of the lower mulgar bushes. Near Kewick's large group of springs, in lat. 13° 54′, on some table-land thickly planted with stringy bark, pines, and other trees and shrubs, the party for the first time saw the fan-palms, some of them growing upwards of fifteen feet high. Again, at Anna's Creek, interspersed with marshy ground thick with trees, bushes, and strong vines, were plains covered with long grass, in this instance reaching to the shoulder of a man on horseback. Such grassy plains appear to be a very common feature, though the grass usually is not of such excessive height, reaching perhaps four feet, and offering sometimes great impediment to the progress of the horses from its dryness, which caused it to break and accumulate before their fore feet. But an inconvenience of a far graver character arose from the habit of the natives of setting fire to the grass. In many places the whole country was burned, and in one instance the explorers had a narrow escape. The country was in a blaze of fire to the east of them, but owing to there not being a breath of wind they were fortunately enabled to pass within a quarter of a mile of it.

No very striking flowers appear to have been met with except those of the bean-tree with bright crimson blossoms, a certain large creeper with yellow blossoms found on the banks of the River Strangways, and "a new kind of lily," evidently a species of Nelumbium, with flowers six inches high, resembling a tulip in form, and of a deep rose colour.

Considering how much the success of a former expedition was frustrated by the hostility and interference of the natives, it is not to be wondered at that Mr. Stuart was extremely wary of them on this occasion, and never sought their company. He was usually very successful in avoiding them, although it would appear that the country is by no means destitute of aboriginal inhabitants. Wherever they go they light a fire, and the smoke gave the travellers an announcement of their proximity. Native smokes seen in all directions is a not unfrequent remark of Mr. Stuart's diary, and it was obviously impossible under these circumstances to avoid them altogether. Accordingly, we have some account of the habits and appearance of this degraded type of mankind. In the neighbourhood of Frew's Water-hole they were visited by a few natives, who appeared to be very friendly; they called water (the great topic of conversation in the interior of Australia) "ninloo." These men were armed with spears, about ten feet long, which are described as having *sharp flint points* about six inches long, with a bamboo attached to the other end. They pointed to the west as the place where they got the bamboo, and the water also, but they appeared to have no knowledge of the country to the north. They were tall, well-made, elderly men, and went away quietly. A fire in the grass, which they ignited next day, almost surrounded and cut off the exploring party. On another occasion, Mr. Stuart, returning from an excursion, found a number of natives, old and young, hugging his men in the most friendly manner. Some pieces of white tape were given to them, which pleased them much. They still pointed to the west as the place where the large water was. On the banks of River Strangways, they came upon a spot where were numerous recent fires of the natives; there must have been a great many of them, for their fires covered the ground. Great numbers of shells of mussels were also found here—the remains of a feast upon those shell-fish. And in another spot they found a favourite camping-ground of the natives strewed with fish bones, mussel and turtle shells. Mr. Stuart seems to hint at cannibalism when he says, that on the pl natives had encamped a day or two before he saw the remains of bones of one of them which had been burnt; and he further describes an apparatus of poles stuck in the ground, making a framework about eight feet high, which he supposes to have been used by them *for smoke-drying a black-fellow.* This, he says, is a new feature in their customs. In many cases the natives ran off as fast as they could as soon as they saw the white men, yelling and squalling fearfully. On being overtaken, one of them held up a green bough as a flag of truce. A singular character was met with on the banks of Roper River. A number of natives being seen to approach the camp about sundown, preparations were made to receive them. They appeared friendly, however, and the attention of Mr. Stuart's party was attracted by an old man, whose legs are described as being about four feet long, and his body in all seven feet high, and so remarkably thin that he appeared to be a perfect shadow. A fish-hook in the hat of one of the whites attracted his attention, and making signs that he wished for it, it was given to him, at which he seemed delighted, and handed it over to his son, a short stout man, who was laughing all the time. But although apparently friendly, it was necessary to be ever on the watch, for they were not to be trusted. They would follow up the party during the night without being seen, though their tracks betrayed them in the morning. They will pretend the greatest friendship one moment, and spear you the next. The women are all small and very ugly.

Of course, in such an adventurous journey, the horses were most valuable auxiliaries, and their efficiency was watched with jealous care. Several mishaps occurred in connection with them. On the 11th of May the packhorse died, leaving them in a very awkward predicament. The want of water told upon the poor animals, and it was necessary sometimes to halt for two or three days to recruit their failing strength. One of the riding horses bolted into the forest, tearing his saddle all to pieces, but was recovered without further accident. On another occasion, one of the horses became bogged in a creek, and was with difficulty extricated; and another, less fortunate, was so completely fixed that in the endeavour to get him out the rope broke, and falling into water he was drowned. The carcase was extricated next day, and dried, and they all enjoyed a delightful change of diet. It was a great treat, "for the horse eats remarkably well, though not quite so good as bullock." Then their shoes came off, and the poor beasts were all lamed, till it was determined to stop and shoe their fore-feet with the shoes which were intended to be saved to take them back over the stony ground of S. Australia. At another time, a horse vanished during the night, and was not seen again. These and similar casualties must have been trying in the extreme to men whose lives depended upon the assistance of these valuable quadrupeds.

At length, on July 25th, everything combined to show Mr. Stuart that they were approaching the seacoast. "Stopped the horses to clear a way (through the belt of scrub fringing the beach) whilst I advanced a few yards on to the beach, and was gratified and delighted to behold the water of the Indian Ocean in Van Diemen's Gulf before the party with the horses knew anything of its proximity. Thring, who rode in advance of me, called out 'The sea!' which so took them all by surprise, that he had to repeat the call before they fully understood, and then they gave three long and hearty cheers. I dipped my feet and washed my face and hands in the sea, and collected a few shells . . . . Thus have I through the instrumentality of Divine Providence been led to accomplish the great object of the expedition, and to take the whole party through, as witnesses to the fact, and through one of the finest countries man would wish to pass—good to the seacoast, with a stream of running water within half a mile of the sea. If this country is settled it will be one of the finest colonies under the Crown, suitable for the growth of any and everything. What a splendid country for producing cotton!" So having hoisted the Union Jack, and buried a record of the discovery at the foot of a tree on which their names were cut, they forthwith commenced the return journey.

This return was made over the same route. Many horses had been lost on the way, and thus the return was rendered proportionately difficult; but excepting some encounters with the natives, difficulties with respect to water, and such accidents, the journey presented nothing remarkable. Mr. Stuart himself, however, fell ill, and at one time scarcely expected to reach home alive. But early in January of the present year this gallant band did reach Adelaide, though Mr. Stuart was but in a weak state of health. Preparations were being made to give them an enthusiastic reception, for their fellow-colonists well know the difficulties of the exploration, and are able fully to appreciate the judgment and success with which it has been carried out.

SCIENTIFIC SUMMARY.

QUARTERLY RETROSPECT.

ASTRONOMY.

Solar and Lunar Eclipses.—A partial solar and total lunar eclipse—the former on the evening of May 17, and the latter on the night of June 1—have been favourably observed throughout the British Islands generally. The small portion of the solar surface eclipsed in the first (only 0·3 at London) produced little if any darkness or other phenomena, and observers could only notice the passage of the moon's disc over some of the spots, and the roughness of the moon's edges when projected on very strong light. The lunar eclipse was more interesting, and the gradual extinction of the moon's white light by umbra and penumbra, until only a dusky red patch was left in the sky, was more remarkable than any seen of late years. In some total eclipses of the moon it has been noticed that its surface is much brighter than on other occasions, and this has been held to be due to the distance of the moon from the earth at the time; *i. e.*, if the moon be at its shortest distance, the shadow (being larger) will more completely envelope the moon, and the latter be in consequence darker, and *vice versâ*. The moon was very near its perigee on the present occasion, so that the very considerable darkness observed may be taken as a further proof of this very natural explanation. The colour of the shadow on the moon was variable as the eclipse proceeded, being at first of an inky or greyish tint; but as the time of total eclipse approached, the hidden portion became gradually redder, the penumbra assuming a bluish colour, which is explained by the contrast between the red and light silvery part of the moon's disc; and the same effect was noticed as the shadow disappeared from the moon. The white spots on the floor of the mountain Plato were even conspicuous as the penumbra passed over that part. Another total eclipse of the moon will not be visible in England for some years, and it is but seldom that one is observed under such favourable circumstances.

Spectra of Stars.—Since Donati's memoir on this subject, published in the course of last year, it has engaged the attention of numerous observers; but the variety of detail seen by Secchi at the Roman Observatory (being probably favoured with a fine atmosphere at the time) is very remarkable, although, as yet, his determinations of the lines of only five stars have been published. Mr. Huggins and Dr. Miller have made a more extensive series on thirty or forty stars, and have been able to obtain microscopic photographs of Sirius and Capella. An ingenious method has been devised by

Mr. Huggins for observing the lines. He having found that the solar line D exactly corresponds with that of the sodium band, makes the latter the starting-point of his measures, having both it and the stellar spectrum which is to be examined, in the field at the same time. By these observations it is to be hoped that not only the chemical constitution but the temperature of the sun and stars may be determined, as it has been discovered that the length of the spectrum depends on the heat of the flame. M. Secchi makes use of Janssen's spectrometer of direct vision, and has been astonished at the magnificent results which he has obtained by it. In Alpha Orionis, he notices a line at F and four between F and G, only one of the latter of which is given by the Greenwich observations. The spectrum of Aldebaran extends still further, and sixteen lines of various breadths have been noticed in it. The spectra of Sirius and Rigel, which are white stars, are somewhat longer than those of the red stars, and the prominent lines appear in the blue and the violet, but are more rare in the less refrangible parts, with the exception of the red. It is remarkable, as Secchi observes, that the ray F is found in all the stars prominently as in the sun, and he considers its origin may be due to the terrestrial atmosphere. From the twenty stars observed at Greenwich, the majority give the same result; which is, however, equally well seen in the line G. There seem to be great anomalies in the different observations of spectra, which will doubtless be soon cleared away.

Companions to Bright Stars.—For some time past, observers have been endeavouring to detect faint stars in the immediate neighbourhood of bright ones, and have succeeded in many instances. Of those the companion of Sirius has been seen by the gigantic telescopes of Clark, Lassell, and Foucault. Latterly, M. Goldschmidt has not only succeeded in refinding it, but has also discovered five others, all of which are immerged in the light of Sirius, and one of them being nearly as close to the principal star as that discovered by Clark. MM. Barclay and Romberg have reobserved a small star close to Procyon, seen by Mr. Hind in 1855, and two other minute stars are noted, but their places not given. It would appear that some faint companions to Procyon have likewise been seen by M. Goldschmidt (*vide* "Les Mondes" of Feb.) Mr. Dawes says that one of the stars seen by M. Goldschmidt near Sirius is easily detected, but the five others could not be observed, and he thinks them *atmospheric* and not *telescopic* tests.

Mars.—Mr. Lassell has made a valuable series of drawings of the planet Mars, taken during the late opposition, and has arrived at some remarkable conclusions in respect to its organism. He finds that whilst the same phase occurs every thirty-nine days, and the planet should appear exactly the same, the seas and continents can rarely be certainly recognized from his drawings, and is therefore of opinion that "if the variously coloured portions do generally represent land and water, their aspect must be greatly modified by the transit of clouds of great extent, density, and variety of form." The white spot at the North Pole was smaller than that of the South Pole. The ruddy portion was more uniform in appearance than the blue or green part, the only distinct marking on the red being a curved streak near the South Pole. On Nov. 4, it was noticed that the bluish portion had a very irregular and hard outline in its darkest part, like the coast-line of a terrestrial continent broken by bays and inlets. Delicate markings were visible on the red and brown parts. Where the white part is near the margin, there appeared to be a protuberance at that part.

Fringes of Light during Solar Eclipses.—The appearance of moving fringes of light seen on a whitened wall during the total eclipse of Dec. 31, 1861, is remembered to have been seen by M. Goldschmidt in the annular eclipse of Sep. 7, 1820. He perceived them fully two and a half minutes before the annulus was formed. He was walking at the time in a direction from east to west, when he saw the moving shadows coming towards him slowly. The movement was not rapid, and the aspect like the shadows of smoke in sunshine; the forms being rhomboids of four or six inches in diameter, mixed up with ribbon-shaped shadows. The inner spaces were filled with round spots mixing gradually with the other in grey transparence. M. Goldschmidt saw this strange apparition whilst he walked for about one hundred steps, when the annulus was suddenly formed, the light of the sun running round the moon like a fluid. At the eclipse of July, 1860, these spots, yellow in colour, were noticed by a Spanish countryman flitting over his white dress from west to east, and the fringes were also seen during the same eclipse by Captain Mannheim in Africa.

Motion of Sun in Space.—From a consideration of the proper motions of stars in space, Sir W. Herschel, Argelander, Galloway, &c., determined that the sun was moving in the direction of the constellation of Hercules; and Struve has even calculated its annual motion towards that point. The Astronomer Royal, however, from discussing a larger series of observations from 1,167 stars, doubted this conclusion; and Mr. Dunkin, by pursuing the same calculations, has arrived at the same result. It may be stated that Mr. Carrington and Professor Fearnley consider it hopeless to determine this problem by investigating it by the method which the former has pointed out—viz., as to whether the direction of the motion of comets before coming into solar influence was different from the concluded motion of the sun. Mr. Carrington, therefore, advises the persevering observation and determinations of proper motions.

Lunar Mountain Plato.—When the moon is full, and circumstances are favourable, by making use of a moderately sized telescope, two or three bright spots may be seen on the otherwise dark surface of the interior of Plato. It was not known whether these were pits, or elevations above the surface. On the evening of April 26, however, Mr. Dawes saw them to great advantage, and they were proved to be veritable craters or pits with elevated surrounding wall, which cast a shadow outwards on one side and inwards on the other. The other round spots were found to assume a similar appearance. There are some other bright spots and streaks which, however, Mr. Dawes considers neither elevated above nor depressed below the surface, like those bright patches which are seen at other parts of the moon. Some of the round spots are so small that it has been impossible to determine whether they are craters or not.

The Lunar Mare Imbrium.—Mr. Birt points out that between the S.W.

part of the Alps as far as Plato, the Mare Imbrium is of a pure dark colour, the uniformity of tint being very remarkable, and not interrupted with bright patches, craters, and roughnesses, as in the other seas.

Occultation of the Star Kappa Cancri on April 26.—Mr. Copeland (near Manchester), in observing the disappearance of this star at the moon's dark limb, noticed that there was an interruption of its light. At first about three-fourths of its light disappeared instantly, and in the interval of half a second the remainer disappeared. This would seem to show that the star was double. The occultation of the star Alpha Scorpii, which is only visible as double to the most powerful instruments presenting the same phenomenon at occultation by the moon, Mr. Dawes has consequently examined Kappa Cancri with the hope of detecting this duplicity, but although seen pretty favourably and examined with magnifying powers of 620 and 1,000, the star seemed perfectly round. Occultations of this star occur on September 9 and November 30 of this year—the latter will be the most favourable for observation. It may be stated, however, that Mr. Burr observed the disappearance of this star on the same night at Highbury, and says that the star disappeared instantaneously.

Sun's Parallax.—This important element—in other words, the distance of the earth from the sun—has been lately determined by Mr. Stone, from a comparison of simultaneous observations of Mars and stars near him, made at the Greenwich and the Victoria (Australia) Observatories. The result gives 8,932 seconds, differing but little from the value found by M. Le Verrier, but very considerably from that of 8,578 deduced from the celebrated transits of Venus of 1761 and 1769.

Deviation in the Direction of Gravity.—The observed co-latitude of the Observatory of Moscow has been found to be eight seconds greater than that given by the geodetic survey; and as there can be no doubt of the correctness of either, it clearly proves a local deviation. As there are no mountains in the neighbourhood, but it is a clear level country, this is the more extraordinary.

Dark Ring of Saturn.—On March 26, 1863, Mr. Carpenter found a great increase in the brightness of the dusky ring of Saturn, which appeared to be nearly as bright as the illuminated ring.

Glass Specula.—The Rev. Mr. Key has invented a new method of polishing the above, which from its success in the hands of amateurs promises excellent results. He polishes to a spherical figure first, and then modifies the figure of the polisher, with which, with the usual stroke and side-motion, he obtains the parabolic figure. By means of a 6¼-inch aperture, Mr. With, of Hereford, has worked one which separates the components of the small star of Gamma Andromedæ.

Parallax of Stars.—M. Krüger has determined the parallax of two new stars of which M. Argelander had established the considerable proper motion. The first is Lalande, 21,258, for which the annual parallax has been found to be 0·260 seconds of arc. The second is Argelander's star, 17·415–6, for which he finds almost the same amount—viz., 0·247 seconds. It is somewhat remarkable that both of those are stars invisible to naked eye—the first being of the 8½ and the second of the 9th mag This would seem to show, which has already been established

Cygni, that it is not the brightest stars which are always nearest to us; only one of the latter, Alpha Centauri, having a considerable parallax.

New Comets and Planets.—The second and third comets of 1863, discovered respectively by Klinkerfues and Respighi, were frequently observed during the months of April and May, but both became much fainter during the latter month. The first was a round nebula, which on April 20 was about 4′ of arc in diameter; the latter on April 26 was visible to the naked eye, with bright stellar nucleus, and a tail of a degree in length. The 78th planet, discovered by Dr. Luther on March 15 last, has received the name of Diana, and was of the 10th magnitude at that epoch. The planet (77) discovered by Peters in November last appears to have been unfortunate, and will with difficulty be refound, as no further observations have been taken, nor its elements computed. Another somewhat luckless planet (Leukothea) comes into opposition in November next, but will be of the last degree of faintness. M. Schubert, however, requests observers with proper means to pay particular attention to it, as he intends to investigate the mass of Jupiter by it—an important object, which shows the utility of even those little bodies.

Spots on Sun and Zodiacal Light.—Professor Wolf, whose labours in respect to the solar spots are so well known, gives further proofs of their periodicity, their relative numbers in the five years 1858—1862 being respectively 50·9; 96·4; 98·6; 77·4 and 59·4. He had previously determined the maximum for 1860-2, and has thence deduced the mean declination variation for Prague and Munich. The connection between the Solar Spots and Northern Lights has been likewise satisfactorily established, the period of the first, which recurs every eleven years, agreeing perfectly with that of the second.

Eta Argûs.—This celebrated variable star, which passes between the 4th and 1st magnitude, and at its latter phase being brighter than any of the stars of the southern hemisphere, has likewise been investigated by Professor Wolf. He finds a period of 46 years. In the curve of brightness given by him, it passes from the 4th magnitude to the 1½ magnitude, then declines to the 2nd magnitude, after this increases to its greatest brightness in 23 years; six years subsequently falls to the 2nd magnitude; whence in five years time it rises to 1½ magnitude, and then decreases to the 4th magnitude.

Jupiter's Satellites and the Pleiades.—It has frequently been argued whether Jupiter's satellites are visible to the naked eye, and equally so as to the number of stars in the Pleiades visible under those circumstances. A member of the Astronomer Royal's family instead of the ordinary six always sees seven, and in favourable weather as many as twelve, and this has been verified by actual mapping. Mr. Mason, on April 15, after gazing with great care at Jupiter, and taking every precaution, detected a luminous point close to the planet which was altogether independent of the radiations, and on looking through his telescope found the satellites clustered at the point which he had previously noticed.

BOTANY.

The Calabar Poison Bean (*Physostigma venenosum*).—The seed of this plant has lately been much noticed for the medicinal properties which reside in it. The most energetic results are obtained from the kernel. These are chiefly marked upon the spinal cord, producing muscular paralysis. When applied locally to the eyeball or eyelids, destruction of the contractility of muscular fibre, and contraction of the pupil result. This property is advantageously employed by the oculist.

Cultivation of Cinchona Trees in India.—Dr. Anderson, Superintendent of the Calcutta Botanic Garden, is inspecting the introduction of Cinchona into the Sikkim Himalayas. His nursery is reported to be in a most flourishing condition, and he has seven species under cultivation. He states that it promises to be a most successful experiment on those moist hills.

Iron as a Tonic in the Vegetable Creation.—It is alleged that a discovery of a curious kind has been made regarding the influence of iron on vegetation. On chalky soils where there is an absence of iron, vegetation has a sere and blanched appearance. This is entirely removed, it is said, by the application of a solution of sulphate of iron. Haricot beans watered with this substance acquired an additional weight of 60 per cent. It is expected that the salts of iron will be found as beneficial in farming as in horticulture, but the experiments are yet very incomplete. In the cultivation of clover, wonderful advantages are declared to have been gained. The material is cheap and the quantity applied is small.

The Flora of Australia.—Dr. Murray, who accompanied Mr. Howitt's expedition as medical officer, has brought back specimens of timber representing seventeen species of trees, the most peculiar of which have received the name of the cork tree, and the orange tree. The fruit of the latter in outward appearance is not unlike a small orange, but it has a pungent flavour, which renders it disagreeable to Europeans, being something between a water-melon and cayenne pepper. The collection of timber, made with great labour, has been sent to Dr. Müller for examination.

The Receptacles of the Juices of Plants.—M. Lestiboudois endeavours to dispel the doubt respecting the existence and nature of latex and laticiferous vessels. He propounds a series of questions, which he answers as the result of his researches. The coloured juices of plants do not resemble (according to this botanist) a fluid which has to furnish organs with the materials of growth, either in their physical properties, in their composition, or in the situations in which they are found. In some plants the reservoirs of the coloured juices constitute a vascular system, so disposed as to follow the vesication of the leaves, and appertaining more particularly to the cortical structure of the stem. The proper juices are more dense, and of a deeper colour in the lower and older parts of the plant, and usually are nearly absent from the root; but in some instances (as *Lactuca sativa*) abound there. The *vasa propria* are, as a rule, distinguishable from neighbouring tissues by the colour of their contents, and by their flexuous, thin, branching, and anastomatic form.

Darnel Grass.—M. Filhol has recently investigated the toxical properties of the *Solium temulentum.* Numerous experiments have been at different times made on animals with this plant; but they have not hitherto led to anything certain concerning the nature of the poison contained in it. M. Filhol has discovered that it contains a double poison—a poison of the strychnine class, and one of the narcotic kind. He has isolated these two poisons, and experiments on animals have shown their special actions, and explained their contradictory effects. M. Filhol adds, that the presence of *Solium* in corn may be shown by the shape of its starchy particles, which are different from that of wheat.

Vascular Bundles in Ferns.—Mr. Church, in a paper published by the Linnæan Society, lays great stress upon the arrangement of these bundles, and from several hundred observations, deduces that there is no marked distinction between the genus *Polystichum* and the genus *Loppodium* (*Lastrea M.*) in this particular. Foreign specimens bear out this result. Also that the genus *Lastrea* (of Moore) contains two British species, and many foreign ones, which possess a totally different arrangement of their vascular tissue, and that this fact, taken in connection with the previously recognized differences of these *very same* species, almost warrants their removal to another genus. And, lastly, that genera whose outward characteristics are conspicuously distinct, exhibit marked differences in the arrangement of their vascular fasciculi, which closely allied genera do not.

Parthenogenesis of Alberia Caffra.—Dr. Anderson, of the Calcutta Botanical Gardens, mentions that this plant, a thorny bush, had been in the gardens some years without producing flowers. It contains pistils only, being diœcious. In March, 1861, it bore a large crop of well-ripened fruit, which was sown, and gave rise to a vigorous stock of young plants. In February, 1862, it flowered again, and the most careful examination led to the detection of no trace of stamens. This tree was unfortunately destroyed a few months ago in a severe gale; but a second specimen artificially propagated from the first still exists in the gardens. It has never flowered.

Sarracenia Purpurea.—This pitcher plant has of late been brought into prominent notice from its supposed virtues in cases of smallpox. Numerous experiments have been made upon its properties, with very various results; some practitioners praising it highly, while others have been disappointed. No doubt that many important discoveries remain to be made in vegetable *materia medica*; but the utmost caution is necessary, lest a hasty conclusion should retard, instead of advancing, the subject.

CHEMISTRY.

MR. MARKHAM, who a few years ago was appointed the superintendent of an expedition for the collection of cinchona plants and seeds, and for their introduction into India, has lately read a paper on this subject before the Society of Arts. Although the difficulties that presented themselves were very great, they have been so effectually met that there are now growing in the Neilgherry Hills and in other parts of India about 130,000 cinchona plants of the most valuable species, the result of the labour bestowed upon the subject.

The greatness of the work will at once be appreciated if it is remembered that the cinchona plant had not yet been cultivated, that its conditions of growth were unknown, that it is found in forests scarcely ever visited by Europeans, and that great care was required in the selection of the species. Mr. Markham, in the prosecution of this undertaking, pointed out the distinction between mere transplantation and that true cultivation which consists in placing the plant in circumstances favourable to its development, and removing hurtful influences.

The importance of the cultivation of this plant cannot be overlooked when the immense medicinal value of quinine, and its present scarcity and high price, are considered. Already, specimens of the bark from these cultivated cinchonas have been analyzed by Messrs. Howard & Sons, who report that they contain as good a per-centage of quinine as the cinchonas from which they have hitherto been in the habit of extracting that alkaloid.

Mr. Lewis Thompson, M.R.C.S., has been making some experiments on nickel with respect to its preparation in a state of purity. He considers that the large quantity of arsenic employed in the manufacture of nickel, and which is very prejudicial to health, is quite unnecessary; for by first roasting the ore, and then heating it with half its weight of chalk, he succeeded in obtaining a rough metal containing 88 per cent. of pure nickel, the rest being cobalt and iron, with a little sulphur, but no arsenic; this metal being decidedly more pure than the ordinary commercial nickel. He proposes, as a method for the analytical separation of nickel and cobalt from other metals, the addition to the warm solution of the mixed sulphates of nickel, cobalt, manganese, iron, copper, &c., of as much sulphate of ammonia as the liquid will dissolve, and to set the solution aside to cool, when almost every particle of nickel and cobalt will separate as double sulphates of nickel and of cobalt with sulphate of ammonia.

The new metal thallium has attracted considerable notice for some time past. From a lecture given by its discoverer, Mr. Crookes, at the Royal Institution, we gather the following particulars concerning this metal :—

The property by which its discovery was effected was that of giving a single brilliant green line when examined by means of the spectroscope. Mr. Crookes was engaged in examining the residue from a manufactory at Tilkerode, in the Hartz, for the purpose of extracting the selenium from it. This was effected in the ordinary way, and the crude selenium was distilled. A considerable residuum was left behind in this operation, in which he suspected the presence of tellurium. Some time afterwards, happening to require some tellurium, he examined this residue more minutely, but without getting definite results; the chemical tests appearing to give contradictory evidence. Recourse was then had to spectrum analysis, when a remarkable green line was observed to cross the field of view. This convinced him that a hitherto unrecognized element was present, and he set himself to the task of isolating it. At first he inclined to the belief that he had a metalloid, or semi-metal, to deal with; but having obtained an additional supply of material, he was enabled to precipitate the substance from solution, by means of zinc, in the form of a black powder, and to obtain it in distinct metallic crystals by voltaic deposition, which removed all doubt as to its metallic nature. It may be as well to remark, in vindication of Mr. Crookes's claim to the priority in the discovery of this metal, that he obtained these metallic crystals in September, 1861.

To obtain the metal in a coherent form, it is only necessary to squeeze the precipitated mass together, and fuse it under cyanide of potassium, or simply to submit it to powerful pressure, when, from its great softness, it will unite into one mass.

Spectrum analysis furnishing an easy method for the detection of the new metal, Mr. Crookes has discovered its existence in varying proportions in many specimens of pyrites, sulphur, sulphide of cadmium, metallic cadmium, and zinc; also in copper and in bismuth ores. A specimen of native sulphur from Lipari was found to contain so much thallium that it might almost be classed as a new mineral.

Thallium is extracted from pyrites by distilling the sulphur from it, the thallium passing away at the same time; the thalliferous sulphur is then boiled with potash, and the black residue heated with sulphuric acid; the solution is then filtered, and hydrochloric acid added to the filtrate, when the difficultly-soluble protochloride of thallium is precipitated; this is filtered off, washed, and converted into sulphate; the solution of the sulphate is then decomposed by means of the voltaic battery.

The chief characteristics of thallium are as follows: It is a white opaque metal, with a perfect metallic lustre; its specific gravity is 11·19; it is very malleable, and may be rolled into leaves as thin as tissue-paper; it is not very ductile, and can only with difficulty be drawn into wire, but, by means of pressure, thallium-wire can be made with great ease. The metal also possesses the singular property of compressibility, and it is the softest known heavy metal, being exceeded in this respect only by the metals of the alkalies. Thallium marks paper like plumbago; the mark fades out from oxidation in a short time, but it may be again rendered visible by moistening the paper with a solution of sulphide of ammonium; with the exception of bismuth it is the most diamagnetic metal known. Thallium melts at 550° Fahrenheit; at a full red heat it may be distilled; it burns in oxygen, and tarnishes very quickly in the air, becoming coated with an oxide which is tolerably soluble in water; the oxide may be rendered anhydrous at the ordinary temperature in a vacuum. The metal dissolves in acids, the proper solvent being nitric acid; it forms at least two basic oxides; the protochloride, like chloride of lead, is slightly soluble in water; bichloride of platinum produces an insoluble double salt with chloride of thallium; sulphuretted hydrogen produces no precipitate in an acid solution; sulphide of ammonium, a black precipitate of sulphide of thallium; on adding ammonia to a solution of the sesquichloride, a brown peroxide is produced, together with protochloride of thallium. In one or two of the properties here alluded to, thallium approaches the metals of the alkalies, but the great majority of its characteristics point out that its true position is by the side of silver and lead.

The decomposition of chlorate of potash in the presence of oxides of manganese and copper has been studied by M. Wiederhold. He found that, contrary to M. Schönbein's hypothesis, oxygenated bodies are not the only ones capable of determining the decomposition, for that spongy platinum had the same power. A rise of temperature was found to take place in the mixture as soon as the bath in which the retort was placed had reached a temperature of 250° for the mixture of chlorate and peroxide of manganese, and 290° for the mixture with oxide of copper. Oxygen began to be given off at temperatures varying from 200° to 285°, according to the mixture employed.

M. St. Clair Deville has made some interesting discoveries connected with the decomposition of bodies by heat. On passing a current of hydrogen through a porous earthen tube, it diffuses so rapidly that the gas which issues from the other end of the tube will be found to be not hydrogen but air. If the porous tube is surrounded by a larger and shorter tube of glazed porcelain into which carbonic acid is passed at one end, the two gases will be found to have changed places by the time they reach the other end of the two tubes.

When these tubes are heated to a temperature of 1,100° to 1,300° C., and a current of steam passed through the inner one, while a carbonic acid is passed through the outer tube, the gas collected consists of hydrogen and oxygen, mixed with carbonic acid.

M. Deville considers the decomposition of a substance to be in all respects analogous to the ebullition of a liquid; water is completely decomposed at a temperature sufficient to expand the vapour to tenfold its volume at 0° C. The decomposition can also take place at lower temperatures, the phenomenon being in this respect analogous to that of the evaporation of liquids below their boiling points. M. Deville has also extended his observations to the dissociation of carbonic acid by means of heat.

GEOLOGY AND PALÆONTOLOGY.

PROFESSOR RAMSAY has discussed the significance of the physical breaks and changes of life in the several strata of the Palæozoic system. When he finds that strata have been upheaved, denuded, and had other rocks deposited upon them, he concludes that we here have evidence of an extremely long interval of time unrepresented by any deposit, the vast duration of which may be computed by noticing that the physical break is always accompanied by a change in the life; hence, also, he supposes that a change in the life probably indicates a physical break. From the Lauvention rocks to the top of the Silurians are six of these cases of nonconformity; in the Old Red Sandstone, two; in the Carboniferous strata, one; and one between the Carboniferous and Peruvian; ten in all. Now, in no one of these strata is the duration so long that from bottom to the top all the species change; yet in the breaks one commo finds that not only have the species but most of the genera disappea and been replaced by new forms. The Professor therefore concludes that the Palæozoic *time*, of which we have no record, must be regarded as far longer than that represented by the whole series of known Palæozoic rocks.

Mr. Carter has described the skull of a *Bos primigenius*, from the peat of Reach, in Cambridgeshire, offering more satisfactory evidence than anything hitherto known of the co-existence in England of man with the supposed ancestor of our domestic cattle. The skull was found beneath 7 feet of peat, and with it most of the skeleton, though there were few limb bones, and not many ribs. It was brought to Cambridge, still much covered with peat, and sold. The investing matter was duly removed, and then became visible a chipped stone celt driven far into the skull, and broken off level with the frontal bone. The fracture was old, the flint was old, the bone around it was depressed, and the weapon, which passed obliquely through the sphenoid into the orbit, penetrating the brain-cavity for three inches, was firmly wedged in the skull. The flint appeared to have been one of those elongated narrow forms with sub-parallel sides which are supposed to have been unknown in the earlier Stone age. It was conjectured that the tool had been lashed to a pole, and so used, when the ox was running, to deliver the blow which, from being accidentally oblique, has from its violence snapped the celt. Mr. Carter did not regard the specimen as bearing on the antiquity of our species, and thought it rather an evidence that the beast lived to very modern times than that man was an ancient denizen of the land. This is an echo of the idea broached by Mr. Prestwich on the chipped flints from the gravel, and cannot be received with too great caution, for the facts of the case are these:

Here in the peat of the Bedford Level are found *Bos primigenius*, *Bos frontosus*, *Cervus Hibernicus*, and *Bos longifrons*, all of which are extinct; the last species going for little, since it frequently occurs in Roman graves. The existing species are not animals now common in the country, and must all be regarded as becoming extinct; among them are the brown bear, the wolf, otter, beaver, wild hog, roebuck, red deer, &c., altogether not more than twelve. Now, when one-fourth of a fauna has died out, and the remainder, even though for obvious reasons, disappeared, it cannot but be supposed that the change indicates a remote antiquity for the stratum in which their remains are entombed. Had the skull been an ordinary one, unassociated with human work, beyond question this antiquity would never have been doubted; and, therefore, the legitimate conclusion from a specimen like this seems to be, that in the days of the *Irish Elk*, beef was already the food of a Briton, courageous and skilful enough to hunt and slaughter the most formidable beast of his time.

Professor Harkness has written elaborately on the Skiddaw slates, tracing their features through the Lake district. He estimates their average thickness in the North of England at 7,000 feet. The mineral character varies so much from place to place as to be worthless for division of the deposit into subordinate groups. From both fossil and physical features the Professor regards the Skiddaw slates as of Llandeill age. These strata appear to be the metropolis of the graptolites, and yield to the collector a number of new radiating and branching forms, which are referred to the genera Phyllograptus, Tetragrapsus, Dichograpsus, &c.

Professor Rupert Jones publishes a monograph of the Estheriæ, crustaceous creatures with a carapace in two pieces, so like bivalve shells that they have been referred to as such by the best authorities. The living forms all inhabit ponds and fresh water, being rarely found in marshes or near the sea. There are fourteen fossil species, ranging from the Old Red Sandstone to the most recent strata. The existing forms being all fresh water, it is thought likely that the same distribution held good for the fossils, and hence that they offer strong suggestive evidence that the fishes of the Old Red Sandstone, like their existing allies, had fresh water habits.

The Rev. O. Fisher has described a bed of peat near Colchester which contains the bones of *Elephas primigenius.* It rests on stratified gravel and is overlaid by brick-earth. This peat contains the remains of insects differing from British existing species, and from their brilliant colours, &c., are thought to have their nearest affinities with those of tropical countries.

Mr. Fergusson has chronicled the recent changes in the Delta of the Ganges. In early historical times, the plains of Bengal were drained by the Brahmapootra passing to the sea by Goalparah, and the Ganges which, passing Rajmahal, ran parallel to it. Then came the upheaval of the Modopore jungle, north of Dacca, producing a depression known as the Sylhet Jheels, into which the Brahmapootra was diverted by the upheaval. The Jheels were gradually filled up, and in the beginning of this century the river returned to its former bed. The result of this was that all the rivers of the western half of the Delta were re-opened, and should the present drainage continue, the two great rivers promise to resume very nearly the courses held before the disturbance. He thinks there is sufficient historical evidence to demonstrate that 5,000 years ago the fruitful rice plains of Bengal were a jungly swamp, with only a few spots on the larger rivers which were inhabitable and capable of cultivation.

MEDICINE, SURGERY, THERAPEUTICS.

MEDICINE.

Diseases of the Liver.—Two very important works on the diseases of the liver have very recently been added to the medical literature of the country; they both contain some new and really scientific observations, based upon studies in physiological chemistry, and are calculated to be of service to the medical profession. One work is the "Clinical Treatise on Diseases of the Liver," by Dr. Freid. Theod. Frerichs, translated by Dr. Murchison for the New Sydenham Society. The other work is entitled "Jaundice: its Pathology and Treatment," by Dr. George Harley, of University College.

It may not be amiss to inform our non-professional readers, that since 1853 it has been known that the liver performs another function besides that of secreting the bile. This organ is also concerned in the formation of a sugar, an amyloid or a starchy principle, the true conditions and pathological relations connected with which are not at present fully known; but it is not discharged like bile into the intestines,—it is taken up by the veins in the liver, conveyed into the general circulation, and becomes subservient to the processes of respiration and nutrition. The liver has therefore two distinct functions, the formation of bile and that of sugar. The latter is called the glycogenic function.

The works of these two authors may be said to represent the latest news on the pathology of certain forms of jaundice; the true theory and explanation of which is yet by no means ascertained. Without attempting to go into a review of these works, we simply recommend them to the favourable notice of the public and to the medical profession as the best standard scientific and practical treatises on liver diseases. The treatment of jaundice and its diagnosis in the work of Dr. Harley shows the great advantages that physiological chemistry offers to explain difficulties, and guide the practitioner in his views of treatment.

The Laryngoscope.—The application of this new instrument (referred to in "Popular Science Review," page 281), invented for examining diseases of the vocal organs, is becoming daily more popular and better known.

Dr. George Johnson read a paper upon the laryngoscope before the London Medical Society in April; Dr. George Gibb lectured before the *élite* of the musical world, at the Musical Society of London; and Dr. Sieveking read a paper before the members of the Harveian Society, each illustrating his discourse by cases and observations. Professor Czermak, the inventor, who is now visiting this country (June 9), gave a clinical demonstration last week at University College Hospital.

The detection of obscure or unsuspected disease is a fact of great value in the diagnosis and treatment, which in the hands of skilful men will reward their labour in this field of research.

Resuscitation and Restoration (of Suspended Animation) from Drowning.—The last volume (xlv.) of the "Medico-Chirurgical Transactions," contains the report of the committee appointed to investigate the subject of suspended animation.* A large number of experiments upon animals, and on the dead body, the result of which are of such importance as to deserve a notice, tend to modify the previously adopted plans for the restoration of persons asphyxiated from drowning.

The method of Dr. Marshall Hall, usually called the postural or ready method, consists essentially "in turning the body round gently on one side, and a little beyond, and then briskly on the face, alternately," making pressure along the back of the chest each time the body is brought into the prone position. Up to the present time this is generally considered the best plan that could be adopted to expel and introduce air into the respiratory cavities or lungs, but no definite information was given as the result of observation and experiments. The committee has undertaken to do this in a very elaborate series of experiments on the dead subject, and it has now fully determined the best method of introducing air into the lungs. The method of restoring the action of the lungs in cases of drowning, introduced last year by Dr. Silvester, may now be considered to be satisfactorily proved to be the best known.

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* The members of this committee were: C. J. B. Williams, M.D., F.R.S.; C. E. Brown-Sequard, M.D., F.R.S.; George Harley, M.D.; W. S. Kirkes, M.D.; Hyde Salter, M.D., F.R.S.; J. B. Sanderson, M.D.; W. S. Savory, F.R.S.; E. H. Sieveking, M.D.

The volume of air inspired, as found upon actual measurement, in Dr. M. Hall's plan "to imitate respiration," varied much, from a few cubic inches to 8 or 10 inches, but never exceeding 15 cubic inches. In Dr. Silvester's plan it was found, on extending the arms upwards, a volume of air was inspired into the chest which varied from 9 to 44 cubic inches, and by bringing down the patient's arms gently, and firmly pressing them against the sides of the chest, so as to diminish the cavity of the thorax, and by alternating these movements, a regular exchange of air was produced, the quantity of which in several instances exceeded 30 cubic inches, and in one instance amounted to 50 cubic inches.

The committee recommends that the plan of Dr. Silvester should be employed in the following manner:—

The body laid on its back (on a flat surface, or a plane slightly inclined from the feet upwards), a firm cushion placed under the shoulders, the head kept in a line with the trunk. The tongue should be drawn forward so as to project a little from the side of the mouth; then the arms should be drawn upwards, until they nearly meet above the head, the operator grasping them just above the elbows, and then at once lowered and replaced at the side. This should be immediately followed by moderate pressure, with both hands, upon the lower part of the sternum. This process is to be repeated about twelve or fourteen times in the minute. As regards facility of application, the plan recommended by Dr. Silvester is equally or perhaps more effective than the Marshall Hall plan.

OPHTHALMIC SURGERY.

Atropine Paper.—Mr. Streatfield has just introduced a portable and convenient substitute for the solution of atropine in ordinary use. He has used green tissue-paper which has been steeped and dried with the solution of atropine, so that one-fifth of a square inch contains enough atropine to dilate the pupil. The small piece of paper is wetted and placed under the lower eyelid, where it causes no pain or inconvenience for the short time required to dilate the pupil. In many cases this small scrap of paper has been found to cause less irritation than the drops of the solution of sulphate of atropine in general use.

The Ophthalmoscope.—A binocular ophthalmoscope has been invented by Mr. Carter, formerly of the Kent County Ophthalmic Hospital. The "Ophthalmoscopic Atlas" of Liebreich is a valuable addition to ophthalmic surgery; it contains twelve well-executed plates, indicating the most interesting appearances in those parts of the eye which have hitherto been recognized by the best observers in the new science of ophthalm

The Calabar Bean.—During the last few weeks observat
going on in some of the London and provincial hospi
properties of the Calabar or ordeal bean in ophthalmic su

This bean, known as the ordeal bean of Calabar, is a very rare plant of the leguminous order, grown only in the King's garden. It was introduced to Dr. Christison some years ago by a missionary named Waddel. Dr. Christison described certain poisonous properties peculiar to it, in the "Pharmaceutical Journal," ten or twelve years back; but the special properties in producing a contraction of the pupil have only recently attracted the attention of ophthalmic surgeons. Dr. Argyle Robertson, Dr. Frazer, Dr. George Harley, Mr. L. Woolcott, Mr. Selberg Wells, all concur in proving it to be of some value in ophthalmic practice, as an anti-medreatic or contractor of the pupil. Its physiological effects are apparently directly opposed to those of belladonna. It may thus counteract the disagreeable and frequently too prolonged action of the solution of atropine in ordinary use in dilating the pupil previous to, and for assisting in, ophthalmoscopic examination.

Mr. J. Woolcott, of the Kent County Ophthalmic Hospital, one of the earliest observers in England, will shortly publish his cases, and it is hoped will confirm the facts by cases and observations.

MATERIA MEDICA AND THERAPEUTICS.

The "New Pharmacopœia."—The "New Pharmacopœia"—that is, the "British Pharmacopœia"—is now almost ready for publication, the proof-sheets having been laid before the General Medical Council. The labour upon this work is immense; it has occupied for some years gentlemen associated with the Edinburgh, Dublin, and London Colleges of Physicians, and with other learned bodies connected with pharmacy. Professor Garrod is the secretary to their committee. This work will form what has long been wanted—a truly national pharmacopœia.

The President of the Pharmaceutical Society, Peter Squire, F.L.S., &c., has just published a work called the "Pharmacopœia of Thirteen of the London Hospitals." It is so arranged in groups for easy comparison with the formulæ of various hospitals, that in future it will be interesting to compare them with the forthcoming work above mentioned, to which it will form a most valuable supplement.

Quinine in India.—To those persons who are watching with interest the growth of quinine in India, it will be gratifying to know that quinine and the other alkaloids known as tonics and useful for their febrifuge properties, have been extracted from the barks of the cinchonas of two years' growth from the Neilgherry Hills. It has been found that the per-centage of quinine, cinchonidine, and cinchonine is as great as can be obtained from the bark of the South American produce.*

Anæsthetics.—As an anæsthetic, chloroform has not yet fully satisfied the expectations of the profession. A committee of some of the members of the Medico-Chirurgical Society has been appointed, and is now actively engaged in experimental inquiries as to the uses, effects, and best modes of administering chloroform. The main object which the committee has in view, is to inquire not only into the practice of employing chloroform by inhalation for surgical operations and in midwifery practice, but to ascertain its results in the treatment of many diseases, such as tetanus, delirium tremens, asthma, epilepsy, hysteria, infantile convulsions, &c.

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* See also Chemical Summary.

Flame-proof or Non-Inflammable Fabrics.—The frequency of accidental death by burning, more especially since crinolines have been in fashion, has given rise to experiments in this country and in France to determine the best means of rendering dresses flame-proof. The most recent researches are by Westerman and Oppenheim, which show that solutions of the salts of sulphate of ammonia, phosphate of ammonia, and tungstate of soda, are those that can be used with greatest facility. For rendering tissues uninflammable these salts combine the conditions of cheapness, and harmlessness to the gloss, colour, and structure of the tissue. The solution may be used in the proportion of one-third the weight of starch, or from 15 to 20 per cent of water. The tungstate of soda appears to have the advantage of the two other preparations, for with starch it forms a better stiffening, and is less liable to be decomposed by the smoothing iron.

Permanganate of Potash as a Deodorizer.—It cannot be too well known that the permanganate of potash is one of the best disinfecting and deodorizing liquids in use. Half a drachm to eight ounces of distilled water are the proportions in which it may be used. It is far superior to any of the chlorine preparations—not so transient in its effects. Suppurating sores, offensive discharges from wounds, ulcers, &c., the removal of bad smells from the nose, breath, and feet, or from carious teeth, and for post-mortem examinations, &c., are some of the more prominent uses to which this solution has been recently applied.

A New Disinfectant.—Charcoal, which has been long known for its antiseptic properties, is now ingeniously used in the form of charcoal paper, or charcoal lint. The carboniferous paper may be applied to ulcerated surfaces, to absorb and at the same time deodorize the liquid discharges, thus preventing the bed from being soiled. The carboniferous paper may be applied to indolent ulcers with good effect. Messrs. Maw & Sons, in London, are agents for the French inventors of this novel preparation of charcoal.

The Ergot of Wheat.—The ergot of wheat may be used as a substitute for the ergot of rye, and possesses some advantages over it. M. Laperdriel, of the College of Pharmacy of Montpellier, has read a paper on this subject, in which he points out the fact that ergot of wheat has all the medicinal properties of the ergot of rye, with the advantage of resisting decay and moisture, hence may be preserved a long time. The ergot of rye is well known to be easily damaged by damp air, and is soon destroyed by mites.

Galvanism as a Remedial Agent.—Mr. Harry Lobb, surgeon to the London Galvanic Hospital, read a paper before the Harveian Society on the uses and value of galvanism and electricity in general practice. As a therapeutic agent, galvanism promises some good results, although they are not yet fully recognized in the profession, but which Mr. Lo
has full confidence will at no distant period be as familiar to
well-educated practitioner in the treatment of disease, as is
administration of drugs. The judicious administration of galva

produced results in the treatment of disease that remain no longer to be doubted.

MISCELLANEOUS.

Poisonous Mushrooms.—The Academy of Medicine in Paris proposes to offer again, in 1864, the Orfila Prize of £160 for the best essay on poisonous mushrooms. Last year three unsuccessful competitors were in the field. The points for inquiry are the following: Give their characters, especially such as may be generally appreciated; examine what effects are produced upon the poisonous or eatable qualities by cultivation, climate, seasons, soil, or exposure; how to separate their toxical principles; indicate their physical and chemical properties; show the means of detecting their presence in cases of poisoning; examine whether the poisonous principle can be separated, and the means of procuring this; its action upon the organism, and the remedies that would be opposed to it.

Cottage Hospitals.—These useful institutions, many of which have been established in different parts of the country during the last three years, continue to flourish. The reports that are issued give encouragement for their foundation in other localities, where the poor are very liable to severe accidents, as in some of the mining districts.

Cranley Village Hospital has six beds; thirty patients were admitted last year, and were treated at a cost of £176. 8s. 2d., leaving a balance of income of £49. 6s. 11d. in hand. Each patient cost £5. 17s. 4d.; the maintenance of each bed about £30 per annum. Each patient was under treatment for an average period of two months; and the report shows that a weekly contribution of 3s. 6d. for each patient is almost enough *to find food and drugs.*

The Water of the Thames.—The question of the purification of the Thames is yet by no means settled; indeed, without some further inquiries and legislation, it may possibly turn out to be a gigantic failure. The District Board of Works of Fulham has memorialized the Metropolitan Board of Works, and made objections to the plan which has been proposed by their Board of deodorizing 9,500,000 gallons daily of the sewage of the western districts of the metropolis at Land's End, Fulham, and casting it into the Thames.

Dr. Letheby has recently issued a report on the waters of the Thames, in which he points out many facts of great value. He finds the middle of the river is invariably charged with a larger proportion of soluble matters than the water near the shores. The saline matters vary from 32 to 100 grains in the gallon; and in certain summer and autumn months, when the evaporation is greatest, it reaches even to 150 grains in the gallon. He finds that when, from a diminished rainfall, the supply of water in the river is mainly from the sea, the mixture of sewage water with the sea water gives rise to a very unpleasant odour and very offensive decomposition. The suspended matters in the water of the river are much increased at the time of the equinoxes. These investigations of Dr. Letheby are worthy of attention in relation to the main-drainage scheme. They show that at certain times of the year the discharge of sewage at Barking Creek will again return with the upward tidal current, and may be prejudicial or dangerous to health from the surface evaporation of so large a bulk of water in constant agitation. The public, the medical profession, and sanitarians generally ought to watch the proceedings of any board entrusted with such vital interests.

MICROSCOPY.

Structure of the Valves of Pleurosigma.—Dr. Wallich calls attention to the error into which most observers have fallen, in supposing that the diagonal and rectangular series of lines (as the case may be) constitute the portions of the valves which, under the high magnifying powers of the microscope, become convertible into the so-termed *dots*, *beads*, or *hexagons*—the fact being (he says) that the *striæ* seen under the lower powers, if properly exhibited, are never convertible into anything but lines, whereas the dots, beads, and hexagons are the imperfect expositions of the structure occurring in the spaces included between the intersections of those lines. Dr. Wallich always prefers oblique light for the examination, and by its use he concludes that he has ascertained beyond question that the marking on *P. angulatum*, *balticum*, &c., is produced by *pyramidal* sharp faces, and finely acuminate elevations on the surface. He is of opinion that the intervening spaces in *P. angulatum* and its allies exhibit elevations, but thinks it probable that the corresponding spots on *P. hippocampus* are occupied by depressions. Dr. Wallich's paper in the "Annals of Natural History" for May, enters very fully into the debated subject, and is worth consulting.

Fermentation produced by Infusoria.—M. Pasteur, in the "Comptes Rendus," confirms a statement laid before the Academy two years since, that there exist infusory animalcules possessing the two properties of living without free oxygen, and of acting as ferments. The new example adduced is the fermentation of tartrate of lime, determined by the presence of an infusory animalcule, existing without free oxygen, and belonging, like that which determines the butyric fermentation, to the genus *Vibro*. He promises to demonstrate in a future communication that there are other animalcule ferments of putrefaction under exposure to air, which are found associated with infusoria, or mucors, that consume the free oxygen, and fulfil the double purpose of agents of combustion with reference to the organic material, and of agents of preservation for the infusoria ferments, by protecting them from the contact of the ozygen of the air.

The Formation of Infusoria.—Professor Wyman, of Harvard College, has made a series of experiments of a most interesting character, in which the results of Pasteur have been in a great measure negatived. Living organisms made their appearance in many instances where even greater precautions were taken than those mentioned by the French observer. In Wyman's experiments, solutions of organic matter, some of them previously filtered, have been boiled at the *ordinary pressure*
for a length of time varying from fifteen minutes
exposed to air purified by heat. In four instances
flasks were unchanged at the time they were opened
Vibrios, Bacteriums, and other organisms appear

instance their presence was indicated, in the early stage of the experiments, by the formation of a film, which took place in some on the second, and in others not till the nineteenth day. The result of the thirty-seven experiments is, that the boiled solutions of organic matter made use of, exposed only to air which has passed through tubes heated to redness, or enclosed with air in hermetically sealed vessels, and exposed to boiling water, became the seat of infusorial life.

The Microscope in Meteorology.—Mr. Sorby has turned the microscope upon meteorites, or rather upon sections of those exotic minerals, with a view to ascertain their origin by close examination of their microscopical structure. The evidence thus far appears to be strong in favour of the conclusion that they are formed by the aggregation of smaller fragments, or minute particles, in which particular they are most nearly resembled, among terrestrial rocks, by consolidated volcanic ashes. Is there anything in this fact of aggregation which touches the nebular hypothesis?

Action of Magenta on Vegetable Tissues.—Mr. J. G. Lynde describes a series of experiments on cuttings of vallisneria immersed in a solution of that dye in glass cells. He finds that, so long as vital action continues, the cell walls and moving chlorophyle retain their green colour, but the injured cells are immediately deeply reddened, and their contents gradually acquire the same colour. Between the cell walls there exists an intercellular membrane of low vitality, which becomes rapidly coloured while the rotation is going on. He further observed what he believed to be traces of cilia, which, when rotation ceased, left irregular markings, either corrugated, or having raised excrescences, which had the appearance which would be produced by cilia falling against the cell wall in various positions upon the suspension of vital action. The chlorophyle vessels appear to resist the action of the magenta for some time after rotation has ceased, indicating a vitality to a certain extent, at least, independent of that of the cell.

New One-twentieth Objective.—Messrs. Smith & Beck have produced a new $\frac{1}{20}$th objective-glass, which is well spoken of. The definition is described as excellent, and the facility of working equal to that of a low power. The improvements which have recently taken place in optical instruments have thus rendered the use of such a glass not only possible, but desirable, although but a few years back glasses of a much lower power were liable to very considerable working objections. In the present case, a large angle of aperture, combined with flatness of field and perfect correction, render the $\frac{1}{20}$th a lens which will do good service.

New One-twenty-fifth Objective.—Messrs. Powell & Lealand have succeeded in making a $\frac{1}{25}$-inch object-glass, magnifying 7,500 diameters, and thus enlarging a given area fifty-six million times; but we are unable at present to say anything concerning the working of this optical marvel.

Cheap French Microscope.—M. Chevallier has announced, through the Imperial Academy of Sciences, that he has constructed a compound microscope of 250 magnifying power, which he can supply at the moderate sum of sixty to seventy francs (50s. to 60s.).

MINERALOGY, METALLURGY, AND MINING.

MINERALOGY.

Petroleum.—Letters from Upper Canada state that an oil-well which some time since ceased to flow has again commenced spouting, and now yields from 300 to 400 barrels a-day. A large quantity of oil is also being taken from the different wells by pumping, and the inhabitants of the district are about to sink a "test-well" of 1,000 feet in depth, to ascertain what quantity may be expected to flow from a greater depth than that yet reached. Dr. Sterry Hunt says it would appear that the Devonian sandstones of Pennsylvania and North-Eastern Ohio are filled with oil, which has risen from the limestone beneath; while over a great portion of Western Canada this limestone was ages ago denuded, and has lost the greater part of its petroleum. Mr. Schorlemmer has analyzed the oil, and finds that the chemical constitution of that portion of it which boils below 120° C. is quite analogous to that of the oil obtained from cannel-tar. The rock-oils of other countries appear to possess a somewhat similar constitution.

The Alais Meteorite.—Professor Roscoe has examined a fragment of this stone, which fell near Alais, in France, in March, 1806. Berzelius, who examined it in 1834, stated that it contained an organic carbon compound, which turned brown on heating, deposited a black carbonaceous mass, and burnt without residue. In 1860 Wöhler discovered traces of a hydro-carbon in two other meteorites from Hungary and South Africa respectively. These facts are remarkable, since in terrestrial matter carbon compounds are solely the results of vital action. Professor Roscoe found that the Alais stone contains at least a half per cent. of a hydro-carbon, which is deposited in crystals when the mass is treated with ether, together with more than one per cent. of free sulphur.

Castor, a mineral discovered by Breithaupt, in Elba, is a silicate of lithia and alumina. It has been lately re-examined by M. Des Cloizeaux, who finds that it must be considered as a variety of petalite, as conjectured by G. Rose, and that it crystallizes in the oblique system. He also finds that castor closely resembles triphane in crystalline form, whilst it differs from that mineral in cleavage, specific gravity, optical properties, and chemical composition.

Astrophyllite.—A mineral hitherto scarcely known has been recently described by Pisani. It is a variety of mica, found in the laminated felspar of a Norwegian syenite at Brevig. It occurs in six-sided tabular crystals, often grouped into stars. Cleavage, basal. It is transparent in thin sheets. Colour, bronze-yellow; streak, golden yellow. Hardness, about 3; specific gravity, 3·324. Before the blowpipe it melts easily with intumescence to a black magnetic enamel. Heated with carbonate of soda and nitre it gives a strong reaction of manganese. The spectroscope distinguishes lime, soda, potash, and lithia. Hydrochloric acid attacks it, with deposition of silica. It differs from most micas in containing very little alumina and much manganese and iron.

Jade.—M. A. Damour has analyzed the mineral known as white or Oriental jade, which is brought from Eastern Asia, fashioned into ornaments. He considers it as an Amphibole of the species Tremolite. Still more recently he has examined specimens of what is called green jade, a mineral made known by the French expedition to China. It is of an apple-green colour, clouded with darker shades often very like emerald. He finds that it differs materially from white jade, being heavier and harder. It also differs in chemical composition, according to which Damour would place it near to the species of Wernerite called Dipyre. He did not succeed in isolating the colouring matter, which he presumed arose from oxide of nickel. He remarks that this mineral must not be confounded with certain jades of a sombre green, pear-green, or olive, which also come from Asia in a worked condition, and which are merely coloured varieties of white jade. For the Werneritic jade he proposes the name jadeite, to distinguish it from the amphibolic jades.

Samarskite is a remarkable mineral found in the Ilmen Mountains, near Miask in the Ural, and also in North Carolina. It contains a large amount of niobic acid and of peroxide of uranium. The analysis of it is attended with considerable difficulty; but Professor H. Rose now shows that to the two former bodies we must add zirconia and thorina as important constituents of the mineral.

Chilian Minerals.—Mr. D. Forbes has communicated some researches on the composition of several minerals of Chili. 1. *A hydrous arseniate of nickel and cobalt*, apparently a new species, occurs in veins in a greenstone rock of the Desert of Atacama. It appears to have been derived from chloanthite, which occurs beneath it. It is found in fibrous masses. Analysis shows its composition to be a bibasic arseniate of nickel and cobalt, with eight atoms of water. It is remarkable from its being colourless, although containing so much of these two metals. 2. *Bismuthic Silver*, a mineral consisting entirely of silver and bismuth, and therefore differing from Dana's so-called bismuthic silver, which is a mixture of various sulphides. 3. *Sulphide of Lead* and *Zinc*, a mineral occurring in large lumps or nodules. It mostly resembles galena, but is lighter and has less lustre than the latter. It may be considered as a compound of two atoms of sulphide of lead to three of sulphide of zinc. 4 *Taltalite*, a new mineral, has since 1858 been found in immense quantities in the mines near Taltal, in the Desert of Atacama, constituting an important ore of copper. It is of a black or brownish-black colour, and occurs in fibrous masses. It is a silicate of copper, united with a silicate of alumina and iron. 5. *Hayesine —Borate of Lime.*—Mr. Forbes believes that his discovery of this mineral and of its mode of formation places beyond a doubt the fact that the compounds of boracic acid occurring so abundantly in Chili and Peru are due to exhalations from volcanoes. It is found in suspension in the waters of hot springs, which derive their boracic acid from volcanic vapours—the acid acts upon the carbonate of lime contained in the water, forming hayesine, the carbonate acid escaping.

Cavities in Topaz, Beryl, and Diamond.—In an interesting paper contained in the Transactions of the Royal Society of Edinburgh, Sir David Brewster describes some remarkable phenomena which he has observed in specimens of each of these minerals. Many years ago he discovered cavities in various minerals, some of which contained two fluids, supposed to be hydro-carbons, whilst in others there were crystals of various forms. In examining minerals by polarized light he has more recently discovered "pressure cavities," the optical properties of which show that the containing mineral while in a soft state has been compressed by an elastic force proceeding from the cavity. He considers that the existence and arrangement of these cavities completes the evidence for the igneous origin of the minerals, and of the rocks which contain them.

Lepidolite.—Several varieties of European lepidolite have furnished the new metals rubidium and cæsium. Mr. O. D. Allen, of Yale College, U.S., examined specimens of the same mineral from Hebron in Maine, and found the new element in comparative abundance. Lepidolite there occurs in large quantity in a coarsely crystalline granite, associated with tourmaline and albite. Like the lepidolite of Penig, in Saxony, it is also associated with the rare species, amblygonite. The Hebron lepidolite contains more than three-tenths per cent. of cæsium.

Conversion of Arragonite into Marble.—By heating arragonite in an iron crucible made as air-tight as possible, and by heating lithographic stone or chalk in a porcelain vessel with a ground stopper, G. Rose and Dr. Siemens have succeeded in producing marble. That prepared from arragonite was especially distinct, and closely resembled Carrara marble. Arragonite, chalk, lithographic stone, and marble, are all varieties of carbonate of lime; when heated in open vessels they lose carbonic acid, and furnish quicklime.

Sulphur in Corfu.—A communication from the Board of Trade states that sulphur has been discovered on the Island of Corfu, and that Professor Ansted has expressed his opinion that the vein is of considerable extent and value. The Newcastle Chamber of Commerce is seeking for further information regarding it.

Minerals of California.—The total value of the gold obtained from all the California mines in 1862 was 42,539,799 dollars. The production of mercury in the State has attained an enormous extent. Last year the amount was 3,025,875 lb.; most of which was exported.

Minerals of Australia.—The "South Australian Register" informs us that Mr. Hargraves has carefully examined Western Australia from King George's Sound to Perth, and has found copper, tin, and silver, but no gold.

Calamine in Tipperary.—Mr. George Darlington has described a remarkable deposit of calamine (carbonate of zinc) at silver mines in Tipperary, which has been found within the last four years. The result of exploration has shown an extensive deposit of this ore, varying from ten to sixty feet thick, and covering a known area of several acres. The deposit seems to occur between two stratified rocks; and it yields an ore which averages about thirty per cent. of metallic zinc when freed from its accompanying ochre. Probably 100,000 tons of marketable ore have been laid open. It is the only deposit of the kind yet discovered in the United Kingdom.

METALLURGY.

Plumbago Crucibles are made of graphite, mixed with a certain amount of clay to render it plastic. Some that are now manufactured are capable of melting on an average forty pourings of the most difficult metals, and a still greater number of those of an ordinary character. They are unaffected by change of temperature, seldom crack, and are very durable. Crucibles of this kind are now adapted for malleable iron melting, and for zinc melting.

Examination of Cast Iron.—When melted pig-iron is tapped into a ladle in moderate quantities, and allowed to stand a few minutes until it becomes perfectly quiet, and then carefully skimmed clean, a beautiful iridescence covers its entire surface, due to the constant breaking up of the extremely thin film of oxide formed on the iron. On close inspection, the coating is found to consist of a multitude of many-rayed stars in constant motion, breaking up and re-forming with great rapidity. It has lately been suggested that, as the size of the different figures is believed to depend on the size of the grain of iron when in the pig, the nature of the former will give an indication of the quality of the iron ; and if instantaneous photographs were taken, they might possibly throw light on the phenomena of the crystallization of iron on cooling and the laws regulating it, about which we require much more information than we possess.

Iron reduced by Peat.—Mr. T. Vincent Lee, C.E., gives some particulars regarding this new application of peat. He took specimens of iron so reduced to the Dublin Exhibition, and it was declared by many of the best judges to be equal to Swedish. The quantity of properly prepared peat per ton of iron is about 1 ton, 15 cwt., the cost being slightly in favour of coal or coke; but the price of the iron made by peat is from £2 to £3 per ton above that from coke or coal. Prepared peat will also, he says, generate and maintain steam quicker and better than either coal or coke ; and machinery is now being made in London to produce it.

Action of Wolfram on Cast Iron.—M. le Guen has made experiments on this subject at the military post of Brest, and finds that cast iron composed of old and new iron, combined in the proportions for giving greatest strength, is made much stronger by the addition of less than 2 per cent. of wolfram. In one case, after two fusions, the resistance to fracture was increased by more than a third. The superiority was maintained after several fusions ; and the cast iron so treated was also rendered tougher and more elastic. The wolfram is easily added, merely requiring to be pulverized without previous reduction.

The Action of Manganese in Iron Smelting.—Captain Caron, in continuing his researches on steel, has applied himself to the effects of manganese in iron ore. He remarks that nearly all good samples of steel come from ores containing much manganese, and it has long been observed that its presence is almost indispensable for the production of superior steel. The results of his experiments he sums up thus :—By the addition of a suitable quantity of metallic manganese sulphur is removed even without refining ; silicon is in great part removed on refining ; whilst phosphorus resists its action altogether. These observations are confirmed by exp ence. Ores giving the best steel never contain phosphorus, whilst they often have sulphur; and although the ores may contain copper pyrites, the derived cast iron is found free from sulphur. Manganese has also the property of making steel better in quality and more durable. A small quantity of manganese is sufficient to retain the carbon in combination, and thus to give steel of good quality. Yet steel should not contain more than a half per cent. of manganese; above this amount it is rendered hard and brittle, losing much of its tenacity. Many forge-masters use, in refining, a mixture of ordinary and manganiferous cast iron. In this case it is of great importance so to reduce the manganiferous ores, that the iron shall contain the largest possible amount of manganese, in order that the maximum effect may be produced in purifying the ordinary iron.

The Desulphuration of Iron.—Professor Richter, of Leoben, Austria, has studied various means of depriving iron of sulphur. One of the best methods hitherto in use is the addition of binoxide of manganese; but it is objected that being infusible it cannot be thoroughly incorporated with the iron; in addition to which commercial oxide of manganese often contains impurities which may be communicated to the iron. Taking into consideration the powerful oxidizing action of litharge (protoxide of lead), he has endeavoured to apply it for the purpose. He finds that it will not only remove sulphur in the puddling process, but it also oxidizes the phosphorus contained in the iron. The experiments were made near Wolfsberg, in Carinthia, with 7 cwt. of pig-iron containing so much sulphur that it was impossible to convert it into bar. To this was added 3 lb. of sulphide of iron and ½ lb. of phosphide of iron. After complete fusion 3 lb. of litharge was introduced, and the fusion continued. The success was complete; the puddled bar proved neither hot nor cold short, and could be forged into iron for scythes; whilst a similar quantity of cast iron puddled without litharge crumbled to pieces under the hammer. Richter adds that in some instances metallic lead may perhaps be preferable to litharge.

The Spectroscope in Steel Casting.—Professor Roscoe, in a paper on the spectrum produced by the flame evolved in the manufacture of cast steel by the Bessemer process, states that during a certain phase of its existence the flame exhibits a complicated but most characteristic spectrum, including the sodium, lithium, and potassium lines. He expresses his belief that this first practical application of the spectrum analysis will prove of the highest importance in the manufacture of cast steel by the Bessemer process.

Applications of Steel.—Experiments have been made in Prussia to ascertain the capabilities and advantages of cast-steel steam-boilers. Two cylindrical egg-end boilers, one of steel, the other of wrought iron, were compared, and after working six months were examined. They were 30 feet long and 4 feet in diameter; the steel boiler-plate was ¼ inch thick. It was tried by the hydraulic test to a pressure of 195 lb. per square inch without altering in shape or showing leakage. After working six months the cast-steel plates were found quite unaffected, and had a remarkably small [illegible] ion as compared with the other boiler. The [illegible] han the latter. Another examination has recently been made, the boilers having been in use for a year and a half. The steel boiler was found in excellent condition. It appeared that it evaporated 11·66 cubic feet per hour, against 9·37 by the common boiler, with about the same expenditure of fuel.——Steel drills for shaft sinking are taking the place of the old iron drills steeled.——Stamp heads for crushing ore have hitherto been made of cast iron, the fragments of which mixed with and contaminated the ore, often causing great trouble. A trial is now being made of steel stamp heads, doubtless with considerable advantage.

Aluminium.—Messrs. Mappin Brothers are exhibiting various articles in aluminium and its alloys. The main portions of the articles are usually formed of the aluminium-bronze, and a good effect is produced by relieving this with ornaments of "oxidized" aluminium whitened by the addition of a small amount of nickel. C. Fissier, director of the aluminium works at Rouen, shows that one per cent. of aluminium in copper makes the latter more fusible, giving it the property of filling the mould at casting. The copper gains in hardness and tenacity without losing its malleability. In transverse strength this alloy was found to be more than twice as rigid as either brass or copper. An alloy of one part of aluminium to a bronze of 96 copper and 4 tin has a fine colour and is very homogeneous. It does not oxidize in casting, and its transverse strength is two and a half times that of the original bronze, and after hammering four times the latter. At a recent meeting at the Royal Institution, Messrs. Johnson & Matthey exhibited an alloy of aluminium and nickel, containing one and a half per cent. of the latter, which has been tried by hydraulic pressure to 476 lb. to the square inch.

Zinc.—M. E. Gatellier, in endeavouring to account for the great loss of zinc in the smelting of its ores, finds that much is due to the porosity of the retorts in which the operation is carried out, and he succeeded in materially reducing the loss by applying a glaze to the exterior of the retorts by means of common salt—the same material that is employed in glazing in potteries. As a secondary advantage, he points out the less injury to the neighbourhood of the works from saving the zinc, which would otherwise escape into the atmosphere. Mr. George Darlington describes the preparation of zinc-white (oxide of zinc) direct from the ore, as it is now practised in America, where the make is from 8,000 to 10,000 tons annually. The furnaces are similar to coke ovens, with flues leading to collecting rooms and chambers of subsidence. The principle adopted is to evolve the zinc in the metallic state by the action of the fuel (anthracite) upon the ore; as it rises in vapour it finds oxygen at a very high temperature, and is thus converted into oxide. Zinc-white is now in great request as a pigment, as a substitute for white lead, over which it has many advantages.

Platinum.—At a scientific meeting held at Bonn, in the beginning of April, M. von Dechen produced two fragments of crucibles in which platinum had been fused with coke by Dr. Carl Bischof. There was evidence of its perfect fusion, and of the great ductility secured. The crucibles were made of clay occurring in the coal-measures of Waldenburg, in Silesia, discovered by Dr. Bischof in his researches on fireproof clays.

Platinum cannot be fused in graphite crucibles, as the carbon unites with the metal, making it very brittle. Messrs. Johnson & Matthey have prepared specimens of autogenous soldering in platinum, with tubes of the same, having cast iron and leaden screw joints for use with sulphuric acid at high temperatures.

MINING.

Blasting.—The Italian Minister of Public Works has reported on the progress of the Mont Cenis tunnel. Boring machines are now used at each end, worked by compressed air. In 1862, to pierce 380 metres on the side of Bardonnèche, 45,751 holes were bored, from 75 to 80 centimetres (30 to 32 inches) in depth; 72,538 borers were set to work; there were 54,875 blasts, and 1,334,000 cubic metres of compressed air were consumed, equal to 8,004,000 cubic metres of atmospheric air. It is expected that at the present rate the tunnel will be completed in 12½ years.——In consequence of the many accidents from ordinary blasting, the far safer plan of blasting by electricity is gradually commending itself to the mining public. It has long been used in military mining with success, and also in civil engineering, where large masses of rock had to be moved, since several charges may be fired at precisely the same moment. Thus, a few months ago, a large martello tower which guarded the entrance to Chatham harbour was demolished. The charges of powder were each 40 lb., distributed at equal distances beneath the foundations; the whole being connected by wires. In this kind of blasting a pair of wires, united at the extremities by a very fine one of platinum, is placed in the interior of the charge of powder. A current of electricity is passed by a magneto-electric machine. The wires may be of any length, and thus the workman may place himself out of danger. Moreover, if the charge miss fire there is no possibility of any smouldering spark, as in the case of the ordinary fuse, which has led to many accidents from this cause.

Ventilation.—It may be remembered that at the time of the late accident at Risca, the ventilating power was a machine. Immediately afterwards a larger machine was erected; mechanical ventilation being still preferred to that produced by the furnace. Lately, the machine got out of order, and a furnace has been erected to supersede it. English mine engineers, as a rule, consider furnace ventilation preferable to mechanical, whilst the majority of continental miners hold the opposite opinion. Mr. Rogers, of Farnley Wood Colliery, near Leeds, has adopted for ventilating power the heat of coke ovens, which may be placed either at the bottom of the upcast shaft, or at the surface. The system is said to work admirably; and at the same time coal slack, unsaleable at 1s. per ton, is converted into good coke worth 5s. per ton.

Testing Air in Mines.—Mr. W. Keene, the Government examiner of coal fields in New South Wales, has invented a simple apparatus for estimating the salubrity of the air in mines. It is a closed tin box with a glass window in one of its sides, and containing a candle holder. A candle is lighted and inserted, after which the box is closed. It is then seen how long the candle burns; the length of time being proportional to the amount of oxygen in the air exami [illegible] with a vessel holding a cubic foot, the candle burnt 6 minutes. In a coal mine, where the air is vitiated, it would not burn so long; and Mr. Keene proposes to prohibit working in places where the candle will burn not more than three minutes.

Safety of the Davy Lamp.—At a late meeting of the North of England Mine Engineers, the President, N. Wood, Esq., stated that at a particular colliery, the workmen always made the gauze of their lamps red hot before using them, in order to expel the oil contained in the wire. Rough experiments had been made, and it was found that new gauze was sometimes capable of passing the flame of gas in consequence of the oil it contained, and which is used in the manufacture of the wire. This may account for explosions which have taken place under mysterious circumstances, and when the lamps have appeared in good condition. Whenever a lamp shows any indication of explosive gas, it should be instantly withdrawn; if this precaution is attended to, the Davy may still be considered a safe lamp. Further experiments are to be made.

PHOTOGRAPHY.

THE principal novelty in the way of photographic materials which we are called upon to notice, is the so-called "enamel paper," intended to be used in printing as a substitute for that prepared with albumen. The new article appears to have been originally manufactured in Germany, but already there are several kinds known in commerce;—all of them are, however distinguished for their fineness of texture and the extreme lustre of their surfaces—peculiarities attributable to the employment of mineral pigments, conjointly with albumen, in their preparation. With regard to their exact nature many statements have been made, and the white pigment has been shown to consist sometimes of sulphate of baryta, and in other samples of oxide of zinc, with albumen in all cases as the adhesive material, and a soluble chloride to furnish the necessary elements for the production of the photographic image. The paper is rather thick, and requires to be manipulated in the same manner as the common albumenized material, with the additional precautions of allowing a somewhat longer interval for the final washing of the prints, and taking care not to crease or fold the enamelled surface, which is somewhat sensitive to incautious handling. Varieties of this enamelled paper may be procured in several tints of colour; among others, pale lilac or rose-pink, serving in the representation of subjects where a degree of warmth of tone is appropriate. This description of paper appears generally suitable for *cartes de visite*, stereoscopic pictures, and others of diminutive size; but the excessive brilliancy of the enamelled surface is, for larger subjects, eminently distasteful.

A suggestion relative to the employment of ammonia for the purpose of "fuming" the sensitized surface of papers used in the printing processes has not yet been entirely disposed of; some authorities adhering to the opinion that such treatment confers great advantages on the score of rapidity of action, as well as in the toning process and subsequent manipulation. The difficulty in securing uniform results, and the inconvenience arising from the diffusion of ammonia gas into the atmosphere of the operating-room are, on the other hand, manifest disadvantages.

The double sulphate of iron and ammonia has taken a permanent position in the list of chemical salts required in photography. As a developing agent this solution answers admirably, whilst it is less prone to oxidation than the simple sulphate. The formula of this compound salt, $FeO, SO_3, NH_4\ O, SO_3 + 6\ HO$, indicates a higher atomic value than the crystallized sulphate of iron, $FeO, SO_3 + 7\ HO$, and a proportionately larger amount by weight must be employed in consequence. For its preparation, two parts of sulphate of iron and one of sulphate of ammonia may be dissolved together in four or five parts of hot distilled water; on cooling, the double salt will crystallize out, and the supernatant liquid may be again used for the solution of further quantities of the individual salts. The crystals, drained and dried on blotting-paper, are still liable to be affected by exposure to air, but in stoppered bottles, and with ordinary precautions, they may be preserved for a long time unchanged. The aqueous solution soon acquires a pale brownish tint, which does not, however, appreciably affect its properties as a reducing agent. When required for the development of collodion negatives, the following formula may be adopted :—

Sulphate of iron and ammonia . .	25 grains
Acetic acid	15 minims
Alcohol.	quant. suff.
Water	1 ounce.

The addition of alcohol is merely for the purpose of causing the liquid to flow evenly over the plate; the quantity usually sufficient would be about thirty minims.

M. Meynier's proposal in reference to the employment of the sulphocyanide of ammonium as a fixing agent, has been favourably reported upon by a committee consisting of MM. Périer, Bayard, Girard, and Davanne, and by others in this country; but the encouragement of low cost is yet wanting as a stimulus to further experiment and more general application.

The composition of photographic prints, as regards their metallic constituents, is still under discussion. Dr. Schnauss maintains that in a properly fixed and toned print, there should not be any silver remaining, but that the whole of this metal is ordinarily dissolved out, and replaced by gold in the successive operations of toning and fixing the proof. MM. Girard and Davanne, Dr. Van Monckhoven, and Mr. Spiller, assert on the contrary that this substitution is not completely effected, and that under all circumstances a fair proportion of silver remains in the proof, and may easily be detected, by chemical analysis, in the ashes left on burning the paper.

Mr. H. Cooper gives the foll [illegible] tions for the preparation of a
kind of gelatino-re [illegible] rposes :—Dissolve
sheet india-ru [illegible] benzole in
such proporti [illegible] ce ;

immerse the bottle in hot water and agitate occasionally until completely dissolved. When cool, the solution is poured into a flat dish, and sheets of paper immersed therein, and after a few minutes removed, drained, and dried; they are then salted by floating upon a solution of chloride of sodium (ten grains to the ounce of water), to which a small quantity of Iceland moss has been added. In order to sensitize this paper, it is treated in the usual manner with a 60-grain solution of nitrate of silver.

The recovery of gold and silver from the waste solutions and products of a photographic laboratory has been proved by Mr. England to furnish very lucrative results; many pounds' weight of an alloy of these precious metals having been recovered from the various residues obtained in the printing operations carried on at his establishment. The paper read by that gentleman at a meeting of the London Photographic Society, on the 5th May, details the steps to be taken in order to effect this saving.

The partial eclipse of the sun visible on the 17th May last, and the total eclipse of the moon on the night of the 1st June, were events which do not appear to have claimed from photographers the amount of attention which such interesting occurrences undoubtedly deserve. Among the records of the solar eclipse which have come under our notice are those of Mr. W. Deane, taken at Richmond, and a series of five larger representations which were photographed at Woolwich by Mr. Spiller. The appearance at the moment of maximum obscuration is well shown in the latter series, whilst Mr. Deane's picture shows likewise a peculiar kind of solar radiation, which assumes somewhat the figure of a cross.

The remarkable photographic observations made by Mr. Glaisher during his last balloon ascent excited a great deal of attention; the principal fact may thus be stated: At an altitude of three miles, with the thermometer registering 21 degrees Fahrenheit, and in the clear atmosphere above the clouds, it was found that sheets of sensitized photographic paper were less affected in colour during thirty minutes' exposure than were similar papers held in the sunlight at about the same time, but for one minute only, within the grounds of the Royal Observatory, Greenwich. Many opinions have been offered by way of accounting for these curious results; and it seems generally admitted that the dry condition of the air would naturally induce a state of inactivity in consequence of the removal from the paper of water, which is so necessary in all these cases for the purpose of aiding chemical decomposition, upon which the darkening in colour depends. In apparent contradiction to these results are the former observations of Professor C. Piazzi Smyth, who states that during his ascent of the mountain in Teneriffe he remarked a gradual increase of chemical activity just in proportion as he gained in altitude; and that in using the camera near the summit he found that the exposure might be very much curtailed. To settle this apparent discrepancy Mr. Negretti recently made an ascent from Sydenham in Mr. Coxwell's mammoth balloon, taking with him a camera and all the materials requisite for carrying on the practice of the collodion process; the car itself being fitted up as an operating-room. He likewise found that the time of exposure at great altitudes might be very much shortened. It thus appears that *in the camera*, as in all cases where it is impossible for the water to evaporate from the film or other prepared surface, there is no indication of the activity of the chemical rays suffering any diminution, but, on the contrary, at these altitudes they are not so liable to b affected or absorbed by transmission through dense air and other media. A further illustration of this fact may be gathered from the statements published many years ago by Mr. Crookes, to the effect that the prismatic spectrum was of greater length and purity, and that the more refrangible solar rays were better defined optically, and endowed with greater photographic activity, at noon on a fine Midsummer day than at any other season of the year; this result being the necessary consequence of their more perpendicular passage at this time through the earth's atmosphere. If now the experimental observations of Mr. Glaisher be considered in connection with the well-known fact that photographic papers lose much of their sensitiveness when deprived, by the action of heat or desiccating substances, of the greater part of their hygroscopic moisture, the interesting announcement of that gentleman may be regarded as furnishing from external nature a confirmatory illustration of this truth, and not be evidence of a notable diminution in the chemical activity of the sun's rays at these great altitudes.

PHYSICS.

DR. W. A. MILLER has been examining the spectrum of thallium, under the influence of a progressively-increasing temperature. It is well known that when thallium is examined in the ordinary way it exhibits in the spectroscope only a single green line of intense brightness. Dr. Miller found that on employing the flame of burning hydrogen, and then of the oxyhydrogen jet, as the temperature increased the brilliancy of the green line also increased, but no new lines made their appearance; but on employing two stout thallium wires as the electrodes of a strong induction coil, by which means a still higher degree of heat was obtained, several new lines which were proved to belong to the metal appeared. In addition to the intense green line, the spectrum contains several very characteristic groups of lines, somewhat similar to those of the spectra of cadmium and zinc, and in a less degree like that of lead.

MM. P. Christofle and F. Beilstein have been examining the spectrum of phosphorus and the coloration of the hydrogen flame by phosphorus and its compounds. A very small quantity of phosphorous acid communicates a beautiful green colour to the hydrogen flame. On examining by means of a spectroscope the flame of hydrogen into which either this substance, phosphorus, or hypo-phosphorous acid was introduced, two beautiful green lines, and a third a little less vivid, appeared. From the extreme sensibility of this method, and the exact results obtained, it is evident that the process may be used for detecting phosphorus in cases of poisoning.

Mr. Gassiot exhibited, at a recent soirée of the Royal Society, a very powerful spectroscope, with nine glass prisms. It showed the yellow sodium line double, the two portions appearing about a quarter of an inch asunder.

Kirchoff has published in the "Philosophical Magazine" for April "Some Contributions toward the History of Spectrum'Analysis," in which he reviews the parts taken by various investigators in the development of this subject. In the same number is a short note by Dr. Roscoe, "On the Spectrum produced by the Flame evolved in the Manufacture of Cast Steel by the Bessemer Process." The author expresses his belief that this first practical application of spectrum analysis will prove of the highest importance in the manufacture of cast steel by this method.

Dr. Joule also describes a new and extremely sensitive thermometer. He states that it is able to detect the heat radiated by the moon. The instrument consists of a vertical glass tube, two feet long and four inches wide, closed at the bottom end, and divided longitudinally by a blackened pasteboard diaphragm, leaving a space at each end about an inch in length. A magnetized sewing-needle is suspended over the edge of the division at the top. The slightest excess of temperature of one side over that of the other occasions a circulation of the air up one side and down the other, which in doing so moves the index.

Mr. G. Gore, of Birmingham, has produced a new and simple furnace capable of smelting cast-iron, copper, gold, &c., without the aid of a bellows or lofty chimney. Its heat is generated by ordinary coal-gas and atmospheric air; its consumption of gas is from 30 to 40 cubic feet per hour; "it has smelted five ounces of copper in four and a quarter minutes, and is capable of fusing half a pound of copper or six ounces of cast-iron;" its size is about that of a Stilton cheese; and it possesses the valuable qualification of continuous access to the contents of the crucible for any length of time without oxidizing it or materially lowering its temperature; the crucible may also be removed or a fresh one introduced without interfering with the action of the furnace.

Some additional experiments "On the Motion of Vapours towards the Cold" is given by C. Tomlinson in the May number of the "Philosophical Magazine." They consist of a few of the subsidiary facts observed during his previous inquiry, which we have already noticed in a previous number of this REVIEW.

Mr. W. R. Grove, F.R.S., has recently delivered a lecture to the Chemical Society, "On the Action of Heat upon certain Fluids." His observations had reference more particularly to the bumping action observed whilst boiling water which has been deprived of its dissolved air. We know that if water has been deprived of air by means of an air-pump, or by means of long-continued boiling in a vessel with a very narrow mouth to exclude the atmosphere, the application of heat is not attended by constant and regular ebullition as when water is boiled in a wide open vessel, but the water is for a short time quiescent, and then suddenly at intervals evolves explosive bursts of steam; and a thermometer immersed in the water shows a variable temperature, hottest just before an explosion and least hot immediately after. A consequence is that no one has yet been able to observe the true boiling-point of water.

The lecturer found that on boiling ordinary water, air containing a slightly increased proportion of oxygen was first driven out; the proportion of oxygen then gradually diminished until pure nitrogen was expelled.

But he had not succeeded, even on boiling nineteen out of twenty parts of the water away, in expelling the whole of the nitrogen. Water that has been so boiled rapidly absorbs air again. His general conclusions were, that water has a very powerful affinity for the gases of the atmosphere, and especially for nitrogen; that by several processes the oxygen may be removed from water, but the nitrogen resists all efforts at separation, and therefore it is doubtful if absolutely pure water had ever been prepared; and that ebullition in water consisted in the production and disengagement of bubbles of steam formed upon a nucleus of a permanent gas.

Several letters to and fro, between Dr. Tyndall on the one hand and Professors Thomson and Tait on the other, respecting the manner in which Dr. Tyndall has treated the claims of Dr. Joule of this country in the subjects of heat, &c., *versus* those of Dr. Mayer on the Continent, have been published in recent numbers of the "Philosophical Magazine," and reach their climax in the number for June, in which Dr. Thomson declines to take part personally in any controversy with Dr. Tyndall.

Dr. Matthieson and Dr. Vogt have examined the influence of temperature on the electric conducting power of thallium, and find that thallium decreases in conducting power about 31½ per cent. between the freezing and boiling points of water.

The Rev. N. Callan describes in the June number of the "Philosophical Magazine" "an induction coil of great power." With this coil he has obtained electric sparks "fifteen inches" in length. This, if we recollect rightly, is less than that obtained by Mr. Siemens with his large induction coil exhibited at one of the soirées of the Royal Society, and described in a previous number of this Review. The length of wire in the secondary circuit of Dr. Callan's coil was "150,000 feet."

Mr. W. Ellis has published in the "Philosophical Magazine" for May an account of some experiments he has been making "on the change of rate produced in a clock by a particular case of magnetic action." He describes the different conditions under which the clock was retarded or accelerated by the influence of approximated magnets.

A paper by Dr. Angus Smith has been read before the Royal Society, "On the Absorption of Gases by Charcoal." He has found that charcoal absorbs oxygen so as to separate it from common air, or from its mixture with hydrogen or nitrogen at common temperatures, and that it absorbs it for at least a month, rapidly at first and slowly afterwards. It does not absorb hydrogen, nitrogen, or carbonic acid for the same period. Water expels mercury from the pores of charcoal by an instantaneous action.

Mr. Hunter, of Queen's College, Belfast, has also been experimenting in the same subject. He finds that logwood charcoal absorbs the most ammonia, fustic charcoal most carbonic acid, and ebony charcoal most cyanogen.

ZOOLOG

Species of Rhinoceros.—Mr. Bl
into the statement of Helfer,

rhinoceros inhabit the region of Burmah. He succeeded during his travels in that country in confirming the existence of the one-horned *Rhinoceros Sondicus*, and the two horned *Rhinoceros Sumatranus*, but believes that these two insular species are the only ones of the Indo-Chinese region; the third species, *Rhinoceros Indicus*, appears to be peculiar to the region at the foot of the Himalayas, and the province of Assam.

The Moa.—A letter from Mr. E. L. Layard, Secretary to Sir George Grey, Governor of New Zealand, states that two species of this bird have been found to maintain a lingering existence in that region. Of one species of comparatively small size (about 3½ feet high) a specimen has actually been killed and eaten by a party of explorers, and fifteen others seen. Of the other species, one of the large Moas, the fresh footsteps, fifteen inches long, have been traced, as Mr. Layard states, by a party who had lost themselves. Both these living species inhabit the little explored Middle Island, never thickly peopled, and nearly depopulated about thirty years since. It is suggested that although tradition points to the recent existence of the Moa, and there are no large animals capable of having exterminated it, the prevalence of bush fires may have had that effect. The probability, however, is that it still exists in some of the untrodden tracts of the Middle Island.

Pulsations of the Heart in Quadrupeds.—In a recent lecture at the Royal Institution Professor Marshall stated that by an ingeniously contrived apparatus, he found the pulsations to increase in frequency as the size of the animal diminishes. Thus in the horse they number 55 per minute; in man 72, in the dog 96, in the rabbit 220, and in the squirrel 300. But whatever the size, the number of beats required to complete the circulation throughout the whole body averages 27; and the proportion of the weight of the blood to that of the whole body is 1 to 12.

Tooth-billed Pigeon.—This bird (*Didemculus strigirostris*), of so great interest as being believed to be the nearest ally of the Dodo, has been discovered to be not quite extinct, as was believed. Mr. Williams, Consul for the Navigator Islands, after several years of unsuccessful efforts, has managed to procure a single living example. A person who visited the Navigator Islands in November last ascertained that, although the bird is now totally extinct at Upolu, a few are still to be found on the island of Sawaii, the largest and most mountainous of the group, and exertions are being made to secure a specimen for the gardens of the Zoological Society.

Struggle for Life.—The Royal Commissioners for inquiring into the operation of the laws relating to the herring fisheries, state that the take of herrings by fishermen within the jurisdiction of the Scotch Fishery Board amounted in 1861 to nearly 900 millions. It is very common to find a codfish with six or seven herrings undigested in his stomach. If we allow a cod only two herrings a-day, and estimate that he feeds on herrings for only seven months in the year, he takes 420 as his allowance during that time; and since at least 2,400,000 codfish were caught in 1861, and the cod and ling caught were certainly not a tithe of those left behind, the destruction of herrings by them alone may be estimated at ten times as great as that effected by all the fishermen put together. The Commissioners add: "A plentiful supply of herrings in any year nourishes an increased army of enemies; and if these latter multiply too fast, the herrings become diminished in number, whereupon the fish that destroy them are starved down, and in a weakened state more easily fall a prey to their own enemies. The herring, then, relieved from their oppressors, in a year or two appear again in immense numbers, and so the alternations of prosperity and panic in the trade which they originate will occur with as much regularity as if the herrings were manufacturers."

Frogs v. *Fishes.*—The Imperial Court of Montpellier have just decided on an appeal in which the point in dispute was whether a *frog* is a *fish.* The judgment was affirmative; and those persons who have hitherto thought that they might catch frogs at all seasons in private or public waters now find that they were mistaken.

Sun-Birds and Humming-Birds.—Mr. Wallace, who has had ample opportunities of observing these birds in a state of nature, and has carefully examined into their relationship, declares that no true affinity exists between the sun-birds (*Nectarinidæ*) and the *humming-birds* (*Trochilidæ*). The sun-birds are a specialized form of an extensive group of typical perchers (*Passeres*). The latter are essentially of the character of *swifts*, profoundly modified for an aërial and flower-frequenting existence, but still bearing in many important peculiarities of structure unmistakeable evidence of a common ancestry. Hitherto these families of birds have been considered as bound together by the closest family relationship, the sun-birds sucking the nectar of flowers by means of a tubular retractile tongue.

New Insect Pest in London.—Mr. E. Newman calls attention to a new insect infesting the Friends' Institute in Bishopsgate-street. He observes that there are two well known to every one—viz., the cockroach and the cricket; but this is a novelty, to which he has given the name of *Lepismodes inquilinus.* It is half an inch long in the body, and the antennæ and tail are also each half an inch in length, so that the whole length of the insect is an inch and a half. It is nocturnal in its habits, and chiefly infests the dining-room, but is frequently caught, from the fact that its feet being non-prehensile it slides down the smooth sides of saucers and basins, &c., and is unable to escape again.

Neuter Ants.—M. Charles Lespés has obtained some singular results from an investigation into the rudimentary reproductive system of neuter ants. He finds that ants do not seek aphides indiscriminately, but that each species seems to have its particular favourites; and in the same manner, those which bring up the larvæ of coleopterous insects, for example, *Claviger*, select certain species for their attentions. He also finds that all neuters have the rudiments of ovaries, developed in a very different manner in different species; and that many have two forms of neuters which sometimes pass insensibly into each other, and are sometimes divided by sharp lines of distinction, forming data for classification.

Aquatic Hymenopterous Insects.—A second species of these remarkable insects has been found by Mr. Lubbock, and named *Walkeria aquatica.* It swims, not by means of its wings, as *Polynema natans*, but h wings motionless under water, and uses its legs only, though neither flattened nor covered with setæ. Respiration appears to take place in the usual way through spiracles. Although 50,000 species of Hymenoptera are known, of which 3,500 live in Britain, until this time no aquatic species was known.

The British Museum.—Professor Owen complains in his annual report of the want of space which causes choice rarities to be added perforce to the vaults intended for storage. The whole number of additional specimens is 28,273.

LIST OF ENGLISH AND FOREIGN POPULAR WORKS ON SCIENTIFIC SUBJECTS, PUBLISHED DURING THE YEAR ENDING JULY 1, 1863.

[The works marked with an asterisk (*) are offered for sale by Messrs. Williams & Norgate, London, in the language in which they are published abroad; we have translated the titles for the guidance of our readers.]

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COX AND WYMAN, PRINTERS, GREAT QUEEN STREET, LONDON.

CT 15 1934